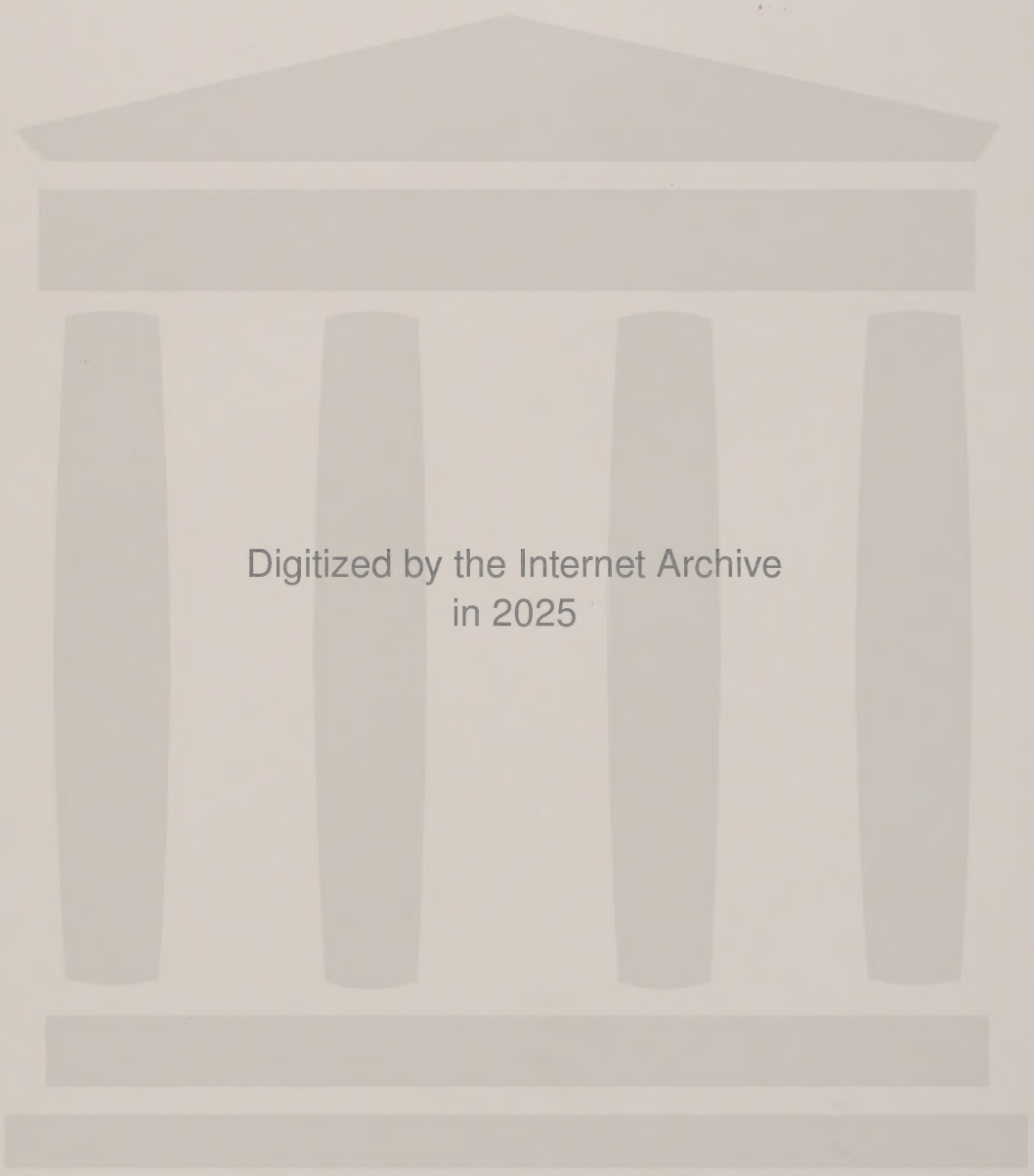
Training Modules on

STRENGTHENING PESTICIDE REGULATIONS

Food and Agriculture Organization of the United Nations

Asian Development Bank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Training Modules
on
Strengthening Pesticide Regulations

Asian Development Bank
and
Food and Agriculture Organization of the United Nations

in cooperation with

United States Environmental Protection Agency
and
Deutsche Gesellaschaft für Technische Zusammenarbeit

December 1989

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The views expressed in this volume are those of the authors and do not necessarily reflect those of their employers or their governments. Nor do these views necessarily reflect those of the Asian Development Bank or the Food and Agriculture Organization of the United Nations.

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FOREWORD

As signatory to the 1980 "Declaration of Environmental Policies and Procedures Relating to Economic Development", the Bank places considerable emphasis on environmental considerations in formulating and implementing its projects. The need for technical and financial assistance to developing countries for managing the use of agricultural chemicals has been highlighted by the World Commission on Environment and Development (convened in 1983 by the General Assembly of the United Nations) in its recent publication *Our Common Future*.

The Bank is committed to promoting environmentally sound economic development. In line with this policy, the Bank published in 1987 a *Handbook on the Use of Pesticides in the Asia-Pacific Region*, intended to guide its own staff, and the officials of developing member countries (DMCs) and the private sector in the selection, procurement and safe and cost-effective use of pesticides.

In the course of the preparation of the *Handbook*, it became increasingly clear that many of the Bank's DMCs were unable to meet the basic requirements of the International Code of Conduct on the Distribution and Use of Pesticides, adopted by all members of the Food and Agriculture Organization of the United Nations (FAO) in 1985.

The Regional Workshop and Symposium on Strengthening Pesticide Regulations held in Manila on 26 June to 7 July 1989 and sponsored by the Bank is part of a worldwide effort to assist developing countries to institute a system for effective regulation and control of pesticide use, supported by both multilateral and bilateral international development agencies. The concept of a Regional Workshop/Symposium was developed by the Bank in consultation with FAO and the United States Environmental Protection Agency (US EPA) in early 1988, with the active participation of the United States Agency for International Development (US AID); Deutsche Gesellaschaft für Technische Zusammenarbeit (Federal Republic of Germany Agency for Technical Cooperation)-(GTZ); World Health Organization (WHO); International Group of National Associations of Manufacturers of Agrochemical Products (GIFAP); and the Government of the Philippines.

The discussions arising from the Workshop and Symposium have special relevance to Bank operations, and provide a valuable source of reference for project preparation by assisting Bank staff in identifying and evaluating the need for both physical inputs and training when implementing the International Code of Conduct on the Distribution and Use of Pesticides.

The objective of the Workshop was to train pesticide regulatory officials of the Bank's DMCs to understand and apply the principles underlying pesticide regulation and to enable them to formulate effective national pesticide regulatory policies in the context of their own environment, institutional framework, and priorities. The registration and regulatory process is complex, especially in the area of data assessment and risk/benefit analysis, and is often beyond the present technical capacity of a number of countries in the Region. In addition, the Workshop provided the opportunity for the Region's DMCs to exchange data and establish a network for future cooperation.

The Bank would like to thank all those who participated in the Workshop and Symposium and in the preparation of the Reports. It is hoped that these two volumes, the first – *Report of the Workshop and Symposium on Strengthening Pesticide Regulations* – containing the Symposium papers and a summary of the Workshop and Symposium discussions, and the second – *Training Modules on Strengthening Pesticide Regulations* – containing the training modules as presented at the Workshop, will provide great value to those in developing countries engaged in the use of pesticides. The two volumes bring together the current approach of multilateral and bilateral donors in ensuring that developing countries facing the urgent need to control pests adopt safe and cost-effective practices.

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December 1989

Contents

Foreword i
List of Abbreviations v

Module A: Overview and Introduction

FAO Guidelines for Legislation on the Control of Pesticides *by Brian B. Watts* 3

Module B: Registration Requirements and Data Assessment

Product Development and Introduction *by Geoff Willis* 15
Pesticide Registration Data Requirements:
Factors Influencing Their Use *by Herbert S. Harrison* 19
Chemical and Physical Properties *by Bill Murray* 21
"Me-Too" Registrations *by Bill Murray and Yuk Y. Wigfield* 25
The Impact of Toxicity Testing on Registration *by Radovan Plestina* 29
Efficacy Data *by A. Balasubramaniam* 33
Residue Data *by Bill Murray* 37
Supervised Residue Trials Conducted at the National Level *by Geoff Willis* 43
Ecological Effects Data - Hazard Assessment *by Henry T. Craven* 47
Pesticide Labeling and Pictograms *by Brian B. Watts* 61

Module C: Post-Registration Activities

Application of FAO Guidelines in Post-Registration Activities *by A. Balasubramaniam* 67
Quality Control in Bangladesh *by Mohammad Mazharul Haq* 68
Quality Control in India *by Manohar Lal Saini* 70
Quality Control in the People's Republic of China *by Zhang Chunjuan* 73

Laboratory Requirements for Regulatory Purposes *by Gero Vaagt* 75
Laboratory Equipment and Manpower
Formulation Analysis in the Republic of Korea *by Han-Kyu Lee* 77
Quality Control in the Socialist Republic of Viet Nam *by Bui Van Ich* 78

Quality Assurance in Testing Laboratories *by Donald J. Hannah* 81

Monitoring the Health Effects of Pesticides *by Nelia P. Cortes-Maramba* 83

Pesticide Disposal Issues *by Edwin L. Johnson* 89
Pesticide Disposal in Malaysia *by Zainal Abdul Rasol* 90
Pesticide Disposal in Sri Lanka *by Nallini De Alwis* 91
Pesticide Disposal in Thailand *by Boonchob Bhatraruji* 92

Pesticide Advertising *by Brian B. Watts* 95
Control of Advertising in India *by Manohar Lal Saini* 98
Control of Advertising in the Philippines *by Nicholas R. Deen* 99
Control of Advertising in Indonesia *by M. Satta Wigenasantana* 100

Control of Pesticide Imports *by Brian B. Watts* 101
Control of Imports in Bhutan *by N. K. Pradhan* 102
Control of Imports in Malaysia *by Zainal Abdul Rasol* 103
Control of Imports in Thailand *by Boonchob Bhatraruji* 104
Control of Imports in Myanmar *by U Maung Maung Tin* 105

Module D: Regulatory Decision Making

Alternative Decision Rules *by Edwin L. Johnson* 109
Benefits Assessment *by Edwin L. Johnson* 111
Balancing Risks Against Benefits *by Edwin L. Johnson* 113
Prior Informed Consent: The Decision Documents *by Brian B. Watts* 117

References 125

List of Abbreviations

ADB	Asian Development Bank
ADI	acceptable daily intake
a.i.	active ingredient
APIP	Agricultural Pesticide Institute of the Philippines
ASTM	American Society for Testing Materials
B	baits
CCPR	Codex Committee on Pesticide Residues
CIPAC	Collaborative International Pesticides Analytical Council Limited
cm	centimeter
D	dusts
DC	direct current
DGD	decision guidance document
DMC	developing member countries
DO	dissolved oxygen
EC_{50}	emulsifiable concentrate 50
ECD	electron-capture detector
EDI	estimated daily intake
EEB	Ecological Effects Branch (US EPA)
EEC	estimated environmental concentrations
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization of the United Nations
FFDCA	Federal Food, Drug and Cosmetic Act (United States)
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act (United States)
FPA	Fertilizer and Pesticide Authority (Philippines)
FPD	flame-photometric detector
g	gram (1,000 mg)
G	granules
GAP	good analytical practice
GATT	General Agreement on Tariffs and Trade
GC	gas chromatography
GIFAP	Groupement International des Associations Nationales de Fabricants de Produits Agrochimiques (International Group of National Associations of Manufacturers of Agrochemical Products)
GLP	good laboratory practice
GTZ	Deutsche Gesellschaft für Technische Zusammernarbeit (German Agency for Technical Co-operation)
ha	hectare(s)
HPLC	high pressure liquid chromatography
ICA	Institute for the Control of Agrochemicals (People's Republic of China)
ICAMA	Institute for the Control of Agrochemicals of the Ministry of Agriculture (People's Republic of China)
ICI	Imperial Chemical Industries
ILAC	International Laboratory Accreditation Conference
IOCU	International Organization of Consumers Unions
IPM	integrated pest management

IRPTC	International Register of Potentially Toxic Chemicals
IRRI	International Rice Research Institute
ISO	International Organization for Standardization
IUPAC	International Union of Pure and Applied Chemistry
JMPR	WHO/FAO Joint Meeting on Pesticide Residues
KASTO	Korean Association of Standards and Testing Organizations
kg	kilogram (1,000 g)
L/l	liter
LC_{50}	lethal concentration 50
LD_{50}	lethal dose 50
MARDI	Malay Agricultural Research Development Institute
µg	microgram (1,000 ng)
mg	milligram (1,000 µg)
ml	milliliter
mm	millimeter
MRL	maximum residue limit
MRTP	Monopolies and Restrictive Practices Act, 1969 (India)
MS	mass spectroscopy
NAMIO	National Agricultural Materials Inspection Office (Republic of Korea)
NAS	National Academy of Sciences (United States)
NATA	National Association of Testing Authorities of Australia
NEL	no effect level
ng	nanogram (10^{-3} µg)
NGO	nongovernment organization
NOAEL/NOEL	no-observed-adverse-effect level
NPD	nitrogen-phosphous detector
ODA	Overseas Development Administration
ODNRI	Overseas Development Natural Resources Institute (United Kingdom)
OECD	Organization for Economic Cooperation and Development
OPP	Office of Pesticides Programs (US EPA)
PAN	Pesticides Action Network
PBA	Philippine Board of Advertising
PHI	pre-harvest interval
PIC	prior informed consent
ppb	parts per billion
PPE	personal protective equipment
ppm	parts per million
PPPD	Plant Production and Protection Department (Socialist Republic of Viet Nam)
SC	solution concentrate
SEP	Standard Evaluation Procedure
SIRIM	Standards and Industrial Research Institute of Malaysia
SPREP	South Pacific Regional Environmental Programme
TDI	theoretical daily intake
TELARC	Testing Laboratory Registration Council of New Zealand
TEPP	tetra-ethyl pyrophosphate
TLC	thin layer chromatography
TMDI	theoretical maximum daily intake
UK	United Kingdom
ULV	ultra low volume

UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
US	United States
US AID	United States Agency for International Development
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency
UV	ultra violet
WDP	water dispersible powder
WHO	World Health Organization
WSP	water soluble powder
>	greater than
<	less than

Measurement and Conversion Charts[1]

Area	hectare	acre	square meter
hectare	1.0	2.471	10,000
acre	0.405	1.0	4,047
square meter	0.0001	0.00025	1

Area	sq meter	sq cm	sq yard	sq foot	sq inch
m^2	1.0	10,000.0	1.19	10.76	-
cm^2	-	1.0	-	-	0.15
square yard	0.83	8,361.27	1.0	9.0	1,296.0
square foot	0.09	929.03	0.11	1.0	144.0
square inch	-	6.45		~ 0.007	1.0

Length	kilometer	meter	mile	yard	foot
kilometer	1.0	1,000.0	0.621	1,093.6	3,281.0
meter	0.001	1.0	-	1.09	3.28
mile	1.6093	1,609.35	1.0	1,760.0	5,280.0
yard	-	0.91	-	1.0	3.0
foot	-	0.30	-	0.33	1.0

1/ Adapted from those in Winand D. E. Staring, Pesticides: Data Collection Systems and Supply, Distribution and Use in Selected Countries of the Asia-Pacific Region, Bangkok: United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), 1984, pp.205-210.

Length	meter	centimeter	yard	foot	inch
meter	1.0	100.0	1.09	3.28	39.37
centimeter	0.01	1.0	0.01	0.03	0.39
yard	0.91	91.44	1.0	3.0	36.0
foot	0.30	30.48	0.33	1.0	12.0
inch	0.02	2.54	0.02	0.08	1.0

Weight	kilogram	gram	pound	ounce
kilogram	1.0	1,000.0	2.205	35.273
gram	0.001	1.0	0.002	0.035
pound	0.454	453.592	1.0	16.0
ounce	0.028	28.35	0.062	1.0

Weight per area	kilogram/ hectare	pound acre	ounce acre
kilogram/hectare	1.0	0.89	14.27
pound/acre	1.12	1.0	16.0
ounce/acre	0.07	0.06	1.0

Module A: Overview and Introduction

FAO Guidelines for Legislation on the Control of Pesticides

By **Brian B. Watts**
Consultant, Pesticide Regulatory Affairs

The recently revised FAO Guidelines for Legislation on the Control of Pesticides deal with the need to legislate all aspects of the control of pesticides, including import, sale and distribution and use of pesticides as well as such post-registration activities as marketing, training, licensing, and enforcement.

General

For the purpose of these Guidelines the term legislation includes the statutes enacted by the national legislative body – acts, laws, and ordinances – and the subordinate enactments such as regulations, decrees, rules, notices, and other relevant legal instruments, passed by the government or an autonomous body.

Legislation must be designed to deal effectively with specific problems applicable in the country, taking into account the economic and social conditions of the country as well as any specific technical requirements such as the crops grown, pest problems, dietary patterns, toxicity of the required pesticides, level of literacy, and climatic and environmental considerations. In introducing a national pesticide control scheme and the legislation necessary for that scheme, it is important to take into consideration the current and future ability of the country to operate the scheme as well as the legal framework and the degree of support which the government of the country is able to provide. Developing countries should design procedures suited to their own specific needs and not necessarily adopt all the elements of a regulatory scheme as may be in operation in another country, particularly a developed one. However, all countries in which pesticides are used should have an effective pesticide registration and control scheme in operation. Such a scheme can help to ensure that pesticide use does not result in unreasonable risk to man, livestock or the environment.

Definitions

It will usually be necessary to list definitions in any legislation, in which case the definitions used in the FAO International Code of Conduct on the Distribution and Use of Pesticides should be followed.

Scope of Legislation

The purpose of legislation on the control and use of pesticides is to enable society to obtain the benefits from their use with minimal adverse effects to man and the environment. The provisions of any pesticide legislation should, as recommended in the Code of Conduct, be concerned with all aspects of the control of pesticides including control of import, sale and distribution and use of pesticides as well as such post-registration activities as marketing, training, licensing, certification and enforcement.

A national authority, which may be designated by the legislative statute to exercise control over pesticides, should be given all necessary powers in that legislation to enable it to carry out its activities. These may include, inter alia, power to issue subordinate enactments, such as notices, rules and guidelines relating to pesticides. It is desirable that all pesticides – agricultural, household, public health and industrial – be included in the legislation. Adjuvants, soil conditioners, human/animal drugs and nutrients could be excluded.

Important Features of the Legislation

Organization and Administration

Primary Authority. The primary authority responsible for the registration and control of pesticides must be identified. While most countries delegate this responsibility to the Ministry of Agriculture, some countries assign this to the Ministry of Health or the Ministry of the Environment. Decision making should not be vested in any one individual or agency, but is, rather, the collective responsibility of representatives from several agencies, preferably those of the government. In some cases, a special authority may be established to control pesticides. Legislation to control pesticides should also require that all pesticides, before they are imported, formulated, packed, labeled, sold or given as a sample, offered for sale, or used, have either a provisional clearance, (including experimental clearance or permit), or a registration, granted by the responsible authority.

Subsidiary Authorities. Other agencies, such as Customs, Health, Environment and Extension Services should work closely with the primary authority in the operation of any scheme for the control of pesticides.

Advisory/Technical Committees. Legislation should permit the establishment of mechanisms to enable the pesticide control functions to be carried out through advisory committees, technical committees or any other means as may be appropriate. Membership should consist of experts in various fields such as efficacy, toxicology, chemistry and environmental impact, and, to ensure that the views of all sectors on pesticide control issues are taken into account, members from various interest groups, such as sellers, users, environmentalists, consumers and government officials should be included as well.

Inspectors and Analysts. To enable the law to be enforced it will be necessary to appoint inspectors, and in countries where there is the capability or legal need to analyze formulations, the appointment of an official analyst will also be necessary. Appointment of such people will be necessary to enable post-registration activities such as those suggested in the Guidelines on Post-Registration Surveillance and other Activities in the Field of Pesticides (see Box 1 for a summary of existing and planned FAO Guidelines). Besides ensuring that the requirements of the law are met, inspectors should conduct regular inspections, and should ensure that product sampling is done in accordance with legislation. The sampling requirements should be described in the legislation. Analysts should be required to receive and analyze samples in a prescribed manner. Powers to be given to inspectors and analysts must be specified in the legislation.

Fees. There should be provision to set fees for the various activities specified in the legislation. Such fees could, for example, cover applications for registration, approval of containers, analysis of formulations and any other activities specified in the legislation.

Appeal Procedures. A provision for appeals, e.g. by the applicant if registration of a pesticide or a provisional clearance is not granted, or if any other decision made by the authorities is contested, should also be covered in the legislation. Such provisions could be channeled either through the normal legal system operating in the country if appropriate, or through special arrangements as specified in the legislation.

Registration

The procedure for obtaining registration or a provisional clearance should be described in the legislation. Registration requirements should cover the following two situations:

- If a pesticide has not been marketed previously, an application for registration or a provisional clearance should be required.
- If a pesticide is registered already or a provisional clearance has been granted, an application for a change in a label claim or an upgrading in the clearance status should be required.

Legislation should specify who may apply for registration. The applicant is usually the person or company who wishes to sell, import or manufacture a pesticide for sale, under a distinguishing name either directly to the user or to a second party for resale, or, who arranges for these activities to be done on his behalf.

Provision should be made in the legislation for the application for registration to be made to the responsible authority on a specified form. The FAO Guidelines for the Registration and Control of Pesticides provide information on what and how much data should be submitted. Legislation should list, in general terms, the data required as part of the application for registration and should include the following:

- the proposed distinguishing name of the formulation;
- a statement of the composition, including all ingredients, and the chemical identity(ies) of the active ingredient(s), and methods of analysis of the formulation;
- adequate toxicological data concerning the active ingredients;
- reports of efficacy trials to support the proposed uses;
- reports of residue trials following the proposed use on crops intended for human or animal consumption, and the methods of analysis for determining residues on these crops;
- reports of environmental effects following the use of the proposed formulation at the proposed rates;
- information on disposal methods for the used container and any surplus pesticide; and
- a copy of the proposed label.

All information to be submitted by the applicant for registration must be treated as proprietary data by the responsible authority. Some of the information may be confidential.

Legislation should also require that a label which has been approved by the responsible authority be firmly affixed to the package before a pesticide can be sold or offered for sale, or given as a free sample. The approved label should contain, and legislation should require that it contains, inter alia, the following information:

- the distinguishing name of the product;
- the common names of all active ingredients;
- directions for use as approved by the responsible authority;
- warning and cautionary statements, including, where required, signs and symptoms of poisoning and information on appropriate safety, health and first aid measures;
- instructions on disposal of used pesticide containers and information on disposal of spills, as may be required;
- any appropriate warning symbols/pictograms;
- the registration number;
- the name and address of the holder of the registration certificate or the provisional clearance;
- the date of formulation and the batch number; and
- any other statements required under the pesticide law or other applicable national legislation.

For further information, reference should be made to the FAO Guidelines on Good Labelling Practice for Pesticides and the FAO Guidelines on Pictograms for Pesticide Labels.

The size of the label as well as the language used, and the system of weights and measures may be specified in the legislation. Such legislation should be consistent with any applicable internationally accepted labeling standards, and with general labeling requirements under any other legislation which may be in force in the country.

Legislation should also allow the registrar to specify the technical requirements for safe and effective packaging of pesticides, taking into account any relevant national requirements or any international standards on the subject. Reference should be made to the FAO Guidelines for the Packaging and Storage of Pesticides.

Legislation may contain special provisions with regard to substances or operations which present a

high or unusual degree of hazard and may include the authority to:

- prescribe conditions for field evaluation of experimental compounds of such substances;
- temporarily prohibit the importation, sale, distribution and use of such substances, even if they are registered;
- restrict the importation, sale and distribution of such substances to ensure their use by only authorized organizations or persons; and
- make any other provisions concerning marketing and/or distribution of such substances as may be necessary to safeguard third parties, the environment and wildlife resources.

Legislation should require the registrar to make a timely decision on the application, after considering the evidence. The decision may be to (i) accept a pesticide for registration; (ii) issue a provisional clearance; (iii) hold the application until further data requested from the applicant are provided; or (iv) reject the application.

When registration is granted, a certificate of registration should be issued, to which is attached either a copy of the printers pull, or a final copy of the accepted label. This should be a requirement in the legislation. No change to the label should be allowed without the approval of the responsible authority.

Registration may be granted for a specified period. Some countries may wish to review registrations regularly, while others may grant registration with no time limits provided the legislation gives them the power to review the status of a product at any time. Provisional clearances, however, should only be granted for a specified time after which they should be cancelled, unless data are supplied to upgrade the claim or a valid reason is given in support of a request for an extension at or before the expiry of the specified time period.

The law should provide for the responsible authority to review the registration or provisional clearance in light of subsequent knowledge about any unfavorable or unforeseen side effects arising from the normal use of the pesticide. Such information may come from reports of additional testing, reports of poisoning cases, deleterious effects on the environment, phytotoxicity to the host plant, or notification of control actions in other countries. Likewise there must be authority in the legislation for the responsible authority to require additional conditions for the manufacture or handling including application of a pesticide or even to revoke that registration or provisional clearance where it has been determined from the review that the continued use of the pesticide is not desirable for technical reasons. If a pesticide is banned or severely restricted, FAO should be notified as part of the Prior Informed Consent procedure. Disposal of any pesticide stocks remaining after any stop sale order is put into effect should be the responsibility of the industry.

Maximum Residue Limits

In many countries the responsibility for setting maximum residue limits (MRLs) lies with the Health Ministry, but in others, where no procedures exist for setting MRLs, this could be covered by the pesticide control legislation, preferably in consultation with the national authority responsible for food quality.

Control of Imports

Legislation should provide that no importation of pesticides be allowed without an appropriate permit from the responsible authority. The authority responsible for registration should coordinate with the customs agency in the exercise of this responsibility.

Licensing and Certification

Some countries may wish to provide for the licensing of various groups of people associated with the manufacture, formulation, repacking, importation, distribution, sale and application of pesticides, such as manufacturers, formulators, repackers, importers, dealers and distributors, and commercial applicators.

Advertising

Any claims made in the advertising of a pesticide should not be in conflict with, or at variance to those claims accepted by the responsible authority. Only pesticides which are registered may be advertised. In some cases, the country may wish to prevent the advertising of those pesticides which have a provisional

clearance. Legislation should make it an offense if a conflict occurs. The International Code of Conduct has established some standards for advertising – Article 11 – which should be followed.

Record Keeping and Reporting

Legislation should require that persons dealing in pesticides keep records for a specified period. These books and records must be available for inspection at all reasonable times.

Enforcement

Legislation should make it unlawful for any person or corporation to carry out a number of operations such as:

- selling or distributing a pesticide which is not registered or which has not been given provisional clearance by the responsible authority;
- selling or distributing a pesticide without an approved label attached to it;
- selling or distributing a pesticide which does not meet the specifications as stated when the product was registered;
- detaching, altering, defacing or destroying any label on the container of a pesticide product;
- repackaging or transferring the contents of a pesticide product unless the new container is labeled with an approved label and unless the operation is carried out in licensed premises;
- advertising a pesticide which is not registered, or has a provisional clearance, or advertising in a manner that is misleading or inaccurate; Article 11 of the International Code of Conduct on the Distribution and Use of Pesticides provides guidance on this.
- supplying a pesticide which is packaged in a container which has deteriorated, or has been damaged so as to be dangerous in storage or transport, or when opened for use;
- using a pesticide in a manner which is not consistent with the conditions on the approved label;
- making false statements or providing false information on the application for registration, or licensing and certification or on required reports or records; and
- knowingly releasing confidential information.

Monitoring

Legislation should provide the responsible authority with powers to carry out post-registration monitoring to enable it to measure the effects of pesticide use. Inspectors should monitor the following: quality of the formulations on the market; whether or not pesticides are being used in accordance with label directions; pesticide residue levels in food; environmental impact of pesticide use; accidental poisoning from pesticide use; and hazards in handling and application.

Training

The responsible authority should have power in any legislation to become involved with the training programs for applicators and users, medical practitioners, dealers and distributors and other groups who may use pesticides.

Binding Provisions

Any legislation on pesticide registration and control should be binding on the government of the country responsible for the implementation of that legislation.

Box 1. Annotated List of Some Guidelines Published or Under Preparation by FAO

Guidelines on Efficacy Data for the Registration of Pesticides for Plant Protection

These Guidelines describe how efficacy data, an essential part of the registration process, should be developed. The need for the development of data on efficacy is established, and some general requirements for the design of the efficacy trial program are described. These Guidelines note that the design of any experiment, including required crop size and methods of evaluation, must be adapted to the specific pest/crop combination and the agricultural practices concerned.

Guidance for designing and reporting individual efficacy trials is provided, including the selection of trial sites; biology of pests, diseases and weeds; lay-out of individual trials; choice of reference product; plot size and shape; method of application; application of pesticides; meteorological data; assessment of efficacy; assessment of phytotoxicity and other side effects; and statistical analysis of data.

Guidelines on Environmental Criteria for the Registration of Pesticides

The risks to the environment from a pesticide depend on many factors such as its toxic properties, the amount applied, the formulation, the method and time of application, and in particular, the intensity of use, mobility and persistence in the environment. The type of data that must be developed prior to registration to allow a reasonable judgment to be made of the environmental behavior of the product when applied according to the recommendations for use is also discussed. Such data are usually predictive, thus it is necessary in most cases to carry out post-registration monitoring.

The primary data needed for predicting environmental effects and the principles of prediction, as well as the need to develop additional data which may be required for predicting environmental effects, are also discussed. Guidelines for actual procedures for such tests are provided.

Guidelines on Pesticide Residue Trials to Provide Data for the Registration of Pesticides and the Establishment of Maximum Residue Limits

Adequate data from properly conducted trials involving crops or animals intended for the production of food are needed to establish the parameters of "good agricultural practices". The levels of residues found following such use form the basis for setting MRLs. It is important that the results of residue analysis in supervised trials relate to those residues which are relevant for the purpose of setting MRLs. It is also important that the food products examined are relevant to the commodity moving in trade.

These Guidelines cover such aspects as the design of residue trials; the sampling of such trials including the sampling of processed commodities; stored products and soils; sample size reduction; sample packing and storage; reporting on the actual residue trials; and analytical requirements. A short section is also included on residue trials on foods of animal origin.

Guidelines for the Registration and Control of Pesticides (Including a Model Scheme for the Establishment of National Organizations)

These Guidelines emphasize the need for control of pesticides, pointing out that the goal in regulating pesticides is to provide society with adequate protection from adverse effects of pesticides while not denying it access to benefits from pesticide use. The Guidelines describe four levels of responsibility associated with the registration of pesticides: the manufacturer, the government, the vendor and the user. The types of regulatory schemes which could

be developed and the legal powers required to operate a scheme are discussed.

For those countries lacking the resources to develop a registration scheme, a less-extensive system may be developed to achieve immediate control of pesticides; a proposal for this scheme is outlined.

Data requirements for a more sophisticated scheme are also outlined and the advantages of a phased registration scheme are discussed. Finally, some general aspects on labeling and packaging, the advantages of harmonizing registration requirements, and aspects of quality control are introduced.

Guidelines for the Packaging and Storage of Pesticides

These Guidelines detail the general requirements of good packaging of pesticides and describe some general standards for containers. The specific selection of appropriate pesticide containers in the case of both solids and liquids is also outlined. The desirability of testing pesticide containers before they are used in commercial trade is emphasized.

Guidelines on Good Labelling Practice for Pesticides

The aim of these Guidelines is to assist people preparing pesticide labels to communicate the essential elements of the safe and effective use of pesticides to the end user by means of a simple, clear standard of labeling. These Guidelines provide specific advice on label design for both industry personnel and government authorities concerned with pesticide registration.

Suggestions on how to increase audience understanding of the labels are provided, as are examples of the various types of labels and useful hints on improving the readability of the label.

The WHO *Recommended Classification of Pesticides by Hazard* is explained, and it is emphasized that this is the preferred system to follow. While the use of pictograms is also discussed, these are explained more fully in a later Guideline.

Guidelines for the Disposal of Waste Pesticide and Pesticide Containers on the Farm

Disposal of unwanted pesticide and pesticide containers is a major problem; these Guidelines address themselves to the problem at the farm level. The Guidelines provide advice to government officials, consultants and others in the field, giving basic information which may be used by them when they are asked for disposal advice. While the best way to dispose of farm level quantities of unwanted pesticide is to distribute them evenly over the land, in accordance with label directions, if this is not feasible, a disposal pit may be required. The Guidelines provide advice on the selection of the disposal site and the construction of the disposal pit.

An Appendix presents various methods of disposal which can be used at the farm level.

Guidelines on Post-Registration Surveillance and other Activities in the Field of Pesticides

A well-designed pesticide registration scheme does not stop at the pre-market evaluation stage. Rather, effective registration schemes incorporate post-registration surveillance to ensure enforcement and monitoring from which it is possible to measure the actual use of the product to ensure that the goals of registration are met.

These Guidelines discuss monitoring activities and, in particular, the quality of the pesticide; whether the pesticide is being used properly; residues in food; environmental monitoring; and accidental poisoning due to pesticides.

The need for training programs for farmers, retail shop personnel, government extension workers and doctors is also discussed.

The question of licensing pesticide handlers at the company, applicator and retail level is addressed.

Finally, the Guidelines cover enforcement and other control measures, such as the control of imports, labeling and advertisements.

Guidelines on the Registration of Biological Pest Control Agents

Biological pest control agents are naturally occurring or genetically modified agents which, because of their differences to conventional pesticides, need different types of data packages for registration. Biological pest control materials usually have unique modes of action, are usually used at very low rates and are quite specific to a target.

These Guidelines identify the various types of biological agents under two main groups, biochemical pest control and microbial pest control agents, and describe in some detail the data requirements considered necessary for the registration of both.

Because biological pest control agents are at the development stage, these Guidelines are interim in nature. They are made available at this time to give regulatory authorities guidance on how best to deal with applications for registration of these materials.

Guidelines on Good Practice for Ground and Aerial Application of Pesticides

These Guidelines are designed to assist pesticide regulatory officials in post-registration surveillance by providing some simple points to users which, when followed, will enable pesticides to be applied safely.

To assist the end users of the pesticide, some simple points on good practice are also identified.

Although many of the practices are applicable to aerial operations, because of the specialized nature of this means of application, some additional points are directed to the pilot, the loader and the marker.

Finally, a special reference to controlled droplet application methods is included.

Guidelines on Retail Distribution of Pesticides with Special Reference to Storage and Handling at the Point of Supply to Users in Developing Countries

While the need to store and handle pesticides safely at the retail level is given considerable prominence in the International Code of Conduct on the Distribution and Use of Pesticides, these Guidelines provide good practical instruction, particularly applicable for developing countries.

The first section on general precautions and requirements covers the need to have safety and first aid equipment available and readily accessible before handling pesticides. Some practical recommendations are given on how to clean up pesticide spills in stores.

The need to store pesticides away from foodstuffs; the need to sell only in the original container; as well as the need to be able to maintain security, to rotate stock, to have a good structure and to maintain good records are addressed in the second section of the publication.

Guidance on the location and structure of godowns or warehouses is provided in the third section. Finally, some practical advice is given to assist in the safe transportation of pesticides.

Pictograms for Pesticide Labels

The use of pictograms — symbols which convey a message without the use of words — has been under discussion for some time. Following a recommendation at the 1982 Government Consultation, GIFAP, in association with FAO, evaluated some designs for suitability for application in the field of pesticides.

A worldwide survey of approximately 1,000 farmers and farm workers from 42 countries was conducted. From three sets of designs evaluated in the survey, the set shown in this publication were most readily understood by the most people from a wide variety of cultural backgrounds and levels of literacy. (For more information on this survey and on pictograms in general, see Watts, p. 61 of this Training Modules volume).

Although Pictograms for Pesticide Labels may be considered as an addendum to the Guidelines on Good Labelling Practice for Pesticides, it is being published as a stand alone document until a revision of the Labelling Guidelines is undertaken.

This FAO publication is complementary to a publication by GIFAP, Pictograms for Agrochemical Labels, An Aid to the Safe Handling of Pesticides, GIFAP, Brussels, 1988.

Addenda to the Guidelines for the Registration and Control of Pesticides

These Guidelines consist of two addenda to the Guidelines for the Registration and Control of Pesticides. The first lists data requirements to be submitted to the regulatory authority when seeking registration of a pesticide. The information, which was compiled from other Guidelines, emphasizes that developing countries need not introduce a comprehensive scheme requesting all the data, as suggested in the list of requirements, to control pesticides effectively. Rather, they may opt to develop a scheme suited to their particular needs or rely on registration in an adjacent country or a country which has a similar climate.

The second is intended to replace Paragraph 13.3 in the Guidelines for the Registration and Control of Pesticides on the subject of proprietary rights to data, an issue which has been under discussion for many years. This replacement is intended to give countries guidance on how they may best protect proprietary data.

Proposed Technical Guidelines

A number of Guidelines discussed at the October 1987 meeting of the Group of Experts on Pesticide Registration Requirements, while in an advanced stage of preparation have for a variety of reasons not yet been finalized. The Guidelines below are under development and are considered by the Group to be required as technical support to the International Code of Conduct on the Distribution and Use of Pesticides.

Guidelines on the Disposal of Bulk Quantities of Pesticides

For the purpose of these Guidelines, the Group defines "bulk" as quantities of pesticide in excess of 100 kilograms in weight, as disposal of surplus pesticide left over from farm spraying is already covered in another FAO Guideline. The document under development will include practical means for reducing the accumulation of waste pesticides. For smaller quantities it is the intention to recommend specific methods of disposal. However for larger quantifies of waste, it will be necessary in most instances to recommend that the advice of a specialist be sought.

Guidelines on the Registration of Household Pesticides

The need for Guidelines on this subject was identified at a regional meeting in Manila. The need was perceived to be greatest in developing countries where there could be year-round use of pesticides in and around the house on almost a daily basis. The household pesticides to be covered in these Guidelines would be defined as a formulation of an insecticide or rodenticide intended to be used by the occupants of a dwelling, in and around that dwelling. It is intended that some of the subject matter in the Guidelines should include:

- the different types of formulations and delivery systems in use, e.g. traps, foggers, a discussion on the products appropriate for target sprays and space sprays;
- the importance of ready-to-use formulations for household use;
- child resistant packaging;
- fire hazards, antidotes, especially for mixtures, a list of generally accepted active

ingredients and their concentrations;

- a table of generally used solvents and a section on those solvents which should not be used and the reasons for this; and

- a specific discussion of methylene chloride and fluorocarbons as solvents for household products.

Guidelines on Prevention of Groundwater Contamination by Pesticides

The contamination of groundwater is a complex subject. The Group of Experts noted that even those countries which had done a great deal of work in this area could still be considered to be at the very preliminary stages of defining and dealing with the problem. The Group therefore divided the discussion of the subject into two sections: contamination of water as a result of poor practices, and contamination as a result of normal, but repeated use of pesticides.

The former could be dealt with to a degree by developing an educational approach stressing prevention and by emphasizing practices to avoid groundwater contamination.

The latter aspect is much more complex, involving, among other things, a knowledge of the hydrogeology and soil types at specific areas, and the chemical and physical properties of the active ingredients.

It is the intention to include a list of the characteristics of those pesticides which tend to be found in groundwater; an indication of the need for standards to be established; and a reference to the WHO drinking water quality standards.

The Group of Experts meeting in December 1989 approved a revised text and it is expected these Guidelines will be available during the first half of 1990.

Guidelines on Personal Protection when Using Pesticides in Hot Climates

An FAO/GIFAP Working Group has been doing some valuable work in this area. A draft document on the subject was discussed at the meeting of the Group of Experts where it was noted that some further field testing would be carried out in tropical areas towards the end of 1988.

It is expected that these Guidelines will cover, in addition to protective clothing, all aspects of protection, including hygiene, avoidance of exposure as well as clean-up procedures. The term protective clothing should include gloves, goggles, and face shields.

In addition, it is the intention to refer to the possible use of national costumes, locally manufactured materials and simple protective clothing such as plastic sheets in the Guidelines.

The Group of Experts meeting in December 1989 approved a revised text and it is expected these Guidelines will be available during the first half of 1990.

Guidelines on Safe Handling of Pesticides During Their Formulation and Packaging

These guidelines are expected to provide information for regulators, as well as to train and advise government inspectors on how best to implement the requirements under the International Code of Conduct for inspectors of formulating and packaging plants. A number of countries already require inspection programs in factories under their national laws.

The Guidelines will also include a section on the need to avoid cross contamination of pesticides, a subject identified by the 1982 Government Consultation as requiring a Guideline.

Module B: Registration Requirements and Data Assessment

Product Development and Introduction

By **Geoff Willis**
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The development of a new crop protection chemical is a complex, time-consuming and expensive process. The objective is to produce a product which will provide an agronomic benefit, without causing unacceptable risks to man and the environment. The outcome is a given product bearing a specific label, sold in a given pack or packs.

This paper highlights some of the key aspects of the development process, as seen from a manufacturer's perspective.

Greenhouse Screening

Initial screening in the research greenhouse is for inherent biological activity. At this early stage, high rates of treatment are applied. Formulations are crude.

Compounds entering initial screening are obtained from two principal sources. Some are custom-synthesized. Others are tested on a random basis.

There are several bases for custom synthesis of compounds, including analogues of chemicals which have already shown activity. Synthesis may arise from imitative chemistry based upon active leads reported by others in, for example, patent literature. They can also include chemicals which are a part of basic research into structure/activity relationships.

As it is impossible to screen every research chemical against every possible weed, pest or disease, representative test targets must be chosen.

A compound, or class of compounds, showing inherent biological activity during initial screening is then subjected to more sophisticated studies in the research greenhouse. At this stage, a better understanding of the biological properties of a chemical begins to emerge, e.g. the preferred means of application (foliar or soil) of a herbicide may become clearer. Tests on a wider range of targets reveal the potential spectrum of activity of the chemical. Increasingly stringent tests as regards rate of application will reveal whether the inherent biological activity seen during initial screening is indeed sufficient to warrant continued evaluation of the material. Many would-be products fail at these early stages.

As the screening in the research greenhouse is undertaken by company staff on company premises, and as the toxicological properties of a new chemical are usually still unknown at these stages, precautions to ensure the safety of company staff and of the surrounding environment must be conservative.

Field Screening

It is not unusual to find promising biological activity in the research greenhouse but disappointing results under field conditions. Thus it is important to test an encouraging new lead under field conditions at an early stage.

As in the case of the research greenhouse, field screening is conducted by company staff on company premises. A network of field testing stations, under both temperate and tropical or subtropical conditions, is used to provide for field screening against a full range of the world's important weeds, pests and diseases. By locating stations in both northern and southern hemispheres, field screening at least twice annually becomes possible.

At around this stage, initial toxicological screening of the potential new product will be undertaken. Of necessity, the tests are limited to simple screening which will provide a general measure of the overall potential toxicity of the chemical.

Field Evaluation

Of the 10,000 chemicals which pass through initial screening in the research greenhouse, perhaps five will enter field evaluation as potential new products. At this stage, inherent biological activity under field

conditions will have been shown already and the compound will have become a candidate for full development.

The purpose of field evaluation is to define the potential development objectives for the compound, including the range of target pests, the likely rate(s), manner and timing(s) of application(s), the range of crops in which the product may be developed and the potential for unwanted phytotoxicity.

By this time the preferred formulation types should have emerged. The choice of formulation type is governed by a series of considerations, both biological and chemical. Biological considerations will include the location of the pest, the time period over which the compound needs to be present to provide the required pest control, and the potential for phytotoxicity. Chemical considerations will include the physical/chemical properties of the compound which may limit the formulation types which, in practice, are capable of being developed. Depending upon the mammalian toxicity of the compound, considerations of safety in use may also limit the formulations which are capable of development.

Compounds undergoing field evaluation will be tested more widely than those in field screening. Much of the work will be conducted by company personnel on crops taken for initial residue analysis or else destroyed. Samples of the compound may be placed with key research cooperators. Depending upon the nature and extent of the field evaluation, including who is doing it, and the regulations of the country in which the work will be undertaken, it may be necessary to seek government approval for the work in advance.

Compounds undergoing field evaluation will also undergo a toxicological and environmental evaluation before entering full development. By this stage, key indicator tests are conducted on parameters which may be crucial to the longer-term acceptability of the product from a safety perspective. For example, the use of short-term genotoxicity studies to predict the potential for carcinogenicity have become increasingly important in the pre-development selection process.

From a manufacturer's perspective, it is important to identify the potential drawbacks as early as possible, before major investments in development have been made.

In parallel with these evaluation stage tests, the process for commercial manufacture will be identified and evaluated. The compound so produced will be used for the toxicological evaluation. Arising from the use rate, market sectors, and costs of production (including capital needed) a financial case will be prepared.

Full-Scale Development

By the time a decision is taken to put a compound into full development, a great deal will be known about the properties of the material, from both the effectiveness and safety points of view. Questions which the manufacturer may wish to ask himself before finally committing to the cost of full development include the following:

- Will it work?
- Can we make and formulate it?
- Have we a sufficient patent position?
- Can we register it?
- Can we sell it?
- Will there be sufficient return on the investment?

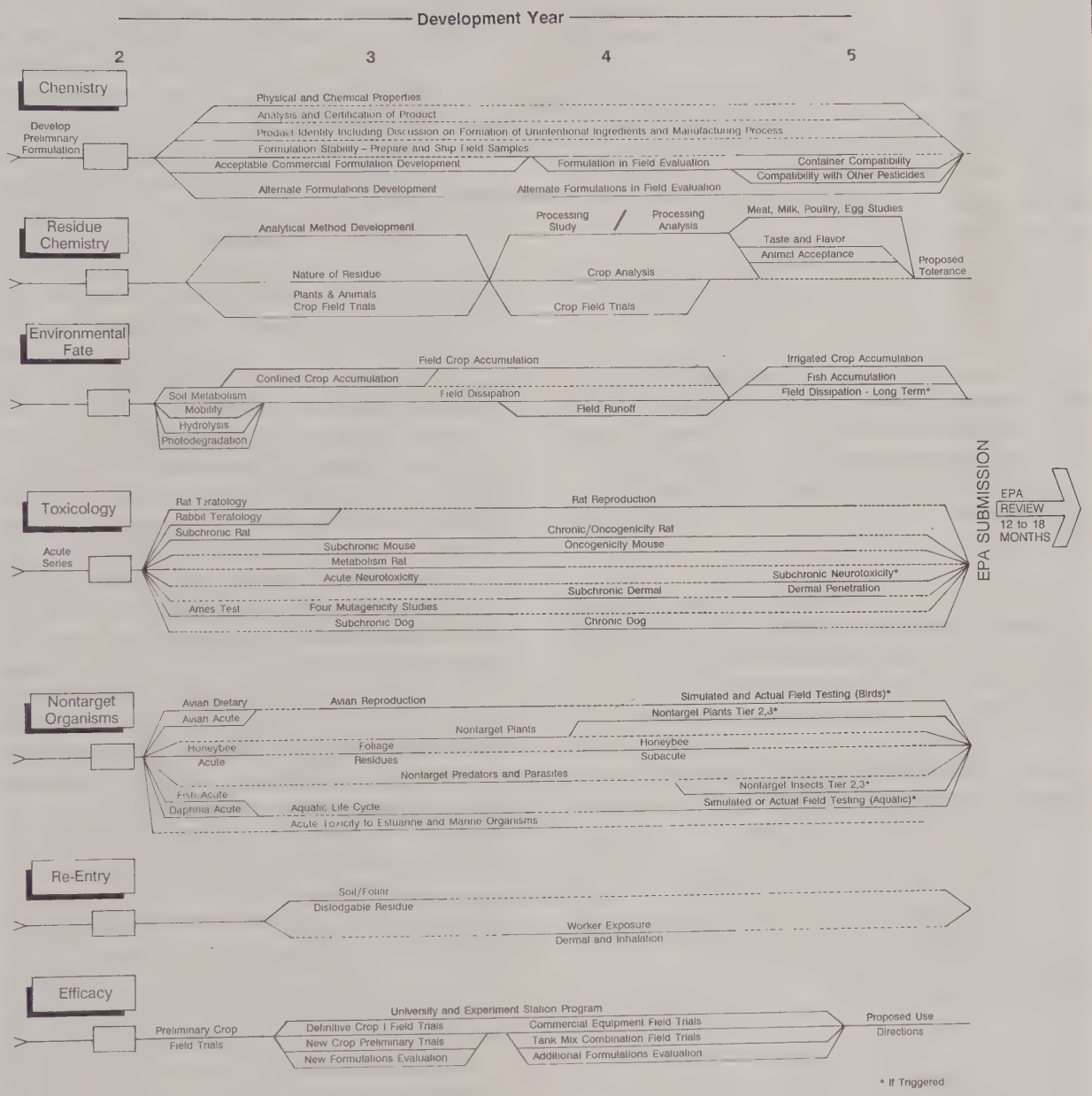
Three main areas of work are undertaken in parallel during full-scale development: (i) efficacy; (ii) manufacture and formulation; and (iii) product safety.

The robustness of the potential new product in many hands, and under many different conditions, will be assessed. The use rates required under different conditions will be refined. The manufacturer is interested in determining the lowest rate at which the compound can be used, while ensuring the required degree of effectiveness. It is as important to the manufacturer to know the limitations, as well as the strengths, inherent in the chemical.

Small refinements in the lead formulation may become necessary. The preferred route of manufacture of the compound is developed and scaled up. Frequently, there are major problems of scale up from early synthesis at the laboratory level to larger-scale manufacture on a pilot plant, and later a full-sized, plant. This is a particularly expensive stage of the development process, often leading to major decisions on the investment of fixed capital.

The other major area of development work is product safety, including safety of personnel

Figure 1. Development of an Agricultural Chemical



manufacturing, formulating or packing the product; of product users; of those who may consume a treated crop, whether people or livestock; and of the environment.

During this stage of development, the preliminary data base is expanded in a sophisticated manner. The first objective is for the manufacturer to assure himself that, when used as anticipated, the product will be effective without causing unacceptable harm to mankind or to the environment overall. These data are subsequently provided to government agencies when the manufacturer seeks approval for sale and use of the product. Development of new data must comply with the requirements of good laboratory practice (GLP) as well as with the various national protocols for studies.

Patents

An extremely important area of work from the manufacturer's perspective concerns patents. In view of the major investment of resources which new product development requires, it is essential that the manufacturer have an adequate period of protection for the new invention to recoup a reasonable return on his investment.

The other aspect of patent work which is crucial to a manufacturer is that of custom synthesis of molecules similar to the lead molecule and a biological screening of them. This is important since, as has been mentioned already, synthesis in areas of chemistry where biological activity is known already will often provide the basis for a new development compound from a second manufacturer.

Product Introduction

Finally, there is no point in developing and registering a new compound if it cannot be sold. Identification of a niche for the product in the market, and in the future structure of that market, is important to the development process. The product has to provide a benefit which will be attractive to the ultimate customer.

The process of new product launch is extremely complex. It requires the existence of appropriate government approvals. It also requires the availability of sufficient formulated product, in the appropriate packs, with the correct labeling, in the required places, at the required time. A supportive campaign to generate additional market awareness of the new product is generally required.

Management of the Development Process

From the foregoing, it is clear that the development process is complex. To be successful, it requires careful and effective management.

Manufacturers must establish, and build upon, the facilities and a multidisciplinary infrastructure which will cover all aspects, including the quality of the work. These must be maintained regardless of the success rate of new chemicals reaching the market.

The time between discovery of inherent biological activity in a new compound and the launch of a new product is now normally 7-10 years, and can sometimes be longer. Costs of development are difficult to assess accurately, although figures of US$50-100 million are frequently mentioned. Overall, one compound in approximately 10,000-20,000 of those which are screened initially in the research greenhouse survives to become a successful product in the market.

Pesticide Registration Data Requirements: Factors Influencing Their Use

By **Herbert S. Harrison**
Chief, Insecticide Rodenticide Branch, Registration Division, US EPA

There are several approaches for determining which data will be required in a pesticide registration scheme. This paper will explore one.

First, the country developing a registration scheme must ask itself what it expects to achieve by regulating pesticides. The answer to that question should be found in the nation's pesticide law. For example, US law mandates that its Environmental Protection Agency (US EPA) shall register a pesticide if, after weighing the benefits and the risks, there are no unreasonable adverse effects that will result when the pesticide is used in accordance with its labeling. Once this overall mandate is clearly understood, data requirements can be specified which will assess the significance of the benefits and risk and, when compared, assess whether the risks are unreasonable.

Among other things, the FAO Guidelines encourage each nation to adopt a pesticide law that clearly identifies the framework for pesticide regulation. Countries should not permit the use of a pesticide if the risks outweigh the benefits. However, as is recognized in the Guidelines, there is significant variation among countries as to the social, economic, political, environmental and pest situations, and not every country will be able to require and review large numbers of scientific studies on which to establish their own scientific conclusions. Therefore, individual countries may need to rely on expertise from other nations to provide such information. Of course the regulatory conclusions which are based on the information generated in these scientific studies may well differ from the regulatory conclusions reached in the country which provided the scientific information.

The FAO therefore encourages each country to establish data requirements tailored to its needs, within its ability to obtain the services of the appropriate scientists and support facilities.

Reasons for Requiring Data

Regardless of a country's ability to develop a large scientific staff to review studies submitted by registrants, all countries need to understand why certain studies are required; what those studies indicate; and how those studies may best be used as a basis for a regulatory decision.

For example, the following considerations would trigger specific data requirements. Some or all (or other) considerations may be critical to any particular program. While the issues are interrelated to some degree, they will vary in relative importance, not necessarily as listed here:

- protection of human health;
- protection of wildlife;
- effectiveness of the pesticide application;
- protection of groundwater, surface water or other environmental medium; and
- protection/promotion of trade considerations.

There is a need to select among these factors when requiring data. For example, in the US we have chosen to de-emphasize pesticide effectiveness (efficacy) data as a registration requirement except in those situations where human health is directly threatened by ineffective pesticide application (e.g. mosquito control or bacterial disinfection of hospital surfaces). This policy evolved over many years and relies on market-place decisions by purchasers to restrain/eliminate ineffective products.

Specific Factors in Determining Requirements

The purpose of testing pesticides and any regulation based on that testing is to permit effective products to

be used without causing significant adverse effects on man or the environment. Where appropriate and possible, a complete and current data base for a pesticide will increase confidence in a regulatory decision. Each study required should serve a purpose and provide essential knowledge to the overall understanding of the consequences of use of that pesticide. Required data should be scientifically defensible and sufficient to withstand challenge and careful peer review. Wherever possible, standard test methods are appropriate so that results can be duplicated and valid comparisons from one pesticide to another can be made.

Because the term pesticide can refer either to the actual pest inhibiting/killing component (active ingredient) or the commercial product (formulation), a comprehensive data base would include studies conducted with both. Studies for which results are pertinent to the active ingredient itself are referred to as generic and often comprise the bulk of the data base. Product specific studies define properties or characteristics of individual commercial product formulations. The latter are usually limited to product chemistry, acute toxicity and product performance (efficacy) data. Commercial formulations are often tested under field conditions to provide representative results with prevailing commercial use patterns.

For pesticide chemicals, data requirements are generally either chemistry, toxicity or efficacy studies. For nonchemical (biological) pesticides, the requirements may be altered to fit the nature of the substance and may be tiered to define how prepared; specificity of effect; host range; and potential for dissemination in the environment.

Process/Product Chemistry. Chemistry data serve several purposes in pesticide regulation. Process or product chemistry data define how the pesticide is produced; its structure, properties and proper nomenclature; and impurities formed during manufacture. The latter may be particularly significant since some impurities (e.g. dioxins, nitrosamines) may be more toxic than the pesticide itself.

Environmental Chemistry. Environmental chemistry data provide details on the fate of the pesticide in the environment following application. Rate of degradation, including formation of metabolites, persistence and mobility can be assessed to predict likelihood of exposure for man or organisms in the environment. The actual list of required data to be included in the study depends on the use pattern. These fate data are particularly helpful for decisions on potential movement to critical nontarget sites such as underground aquifers (groundwater) or bodies of surface water. In some instances, characteristics such as persistence or mobility, coupled with toxicity results could lead to special monitoring, or other types of studies designed to more precisely quantify levels of exposure for man or other nontarget organisms.

Residue Chemistry. Residue chemistry data requirements encompass studies intended to define and predict maximum levels of the pesticide in food or feed crops and/or food animal tissues resulting from use. These requirements are also closely tied to use patterns and include adequate analytical methods to detect such residues on agricultural commodities in commerce. Maximum or "worst-case" exposure of residues of all uses for a given pesticide likely to occur in an individual's diet may be compared with results of toxicity studies to assess adequate margins of safety.

Toxicity Data. Toxicity data requirements typically use representative animal or micro-organism species to define toxic responses (or lack of response) under controlled conditions where the actual influence of the test substance can be most accurately determined. The results of such tests can be extrapolated to predictions for adverse effects on man or other nontarget organisms. The potential for the active ingredient, formulation or any component of its residue to cause acute or chronic injury can be considered. Chronic studies — usually feeding studies but occasionally employing other routes of exposure — can be designed for a specific end-point such as tumor formation or to determine any adverse effect occurring during the term of the study. In the latter case, careful design and dose selection is needed to include a dose level which produces no observed adverse response.

Product Performance Data. Product performance data are intended to evaluate effectiveness of the pesticide under actual use conditions. These data should be representative of climatic conditions and use practices for the areas or regions in which the pesticide is intended. Performance data are also crucial for those situations where pesticides are being compared.

Chemical and Physical Properties

By **Bill Murray**
Chemical Evaluation Division, Food Directorate, Health and Welfare, Canada

To characterize a pesticide compound it is necessary to clearly define its chemical and physical properties in measurable/quantifiable terms. Pesticide manufacturers are required to supply these data to regulatory agencies as part of a comprehensive data package developed in support of petitions for product registration. These submissions include details of the composition of the technical grade material used in the formulation as well as the formulated product itself.

The submitted data allow identification and characterization of the active ingredient in the pest control product proposed for sale, and verification of the label guarantee. Knowledge of the composition of the technical material and formulated product permit an assessment of potential toxicological effects, comparison of products produced from different sources and assurance that the toxicological, residue and efficacy studies were conducted with material of comparable composition. This information is also used in the development of label precautions with regard to safe handling and use, including statements with respect to the need for protective clothing, compatibility (stability) when tank-mixed with other agricultural chemical products and recommendations concerning appropriate storage conditions. The potential environmental fate of the active ingredient may also be estimated based on the submitted data.

Summary

Overall, the principal objectives in developing data on the physical/chemical properties of technical active ingredients and their corresponding formulated products may be summarized as follows:

- to characterize the technical active ingredient with its impurities and microcontaminants (e.g. dioxins, azobenzenes, nitrosoamines) and to permit the assessment of safety to humans and the environment from use of these products;
- to identify and quantify the active ingredient for purposes of the product guarantee;
- to predict the fate in the environment; and
- to provide background data for analytical method development.

Sources of Information

Information on the basic physical chemical properties of pesticide active ingredients may be found in the open literature as well as in publications such as the following:

- Worthing, C.R., and Walker, S.B., eds. *The Pesticide Manual*, 8th Edition. UK: The British Crop Protection Council, 1987.
- *FAO Specifications for Plant Protection Products* (available for a wide range of active ingredients), Rome: FAO.
- *Specifications for Pesticides Used in Public Health*, 6th Edition. Geneva: WHO, 1985.

A number of guidelines are available which define acceptable protocols for the generation of supporting physical and chemical data as well as standardized methods for the quantitative and qualitative analysis of both technical and formulated products:

- Organization for Economic Cooperation and Development (OECD) 1981 *Guidelines for Testing of Chemicals*, Section 1, Physical Chemical Properties.

- *Official Methods of Analysis of the American Association of Official Analytical Chemists* (1984) 14th Edition.

- CIPAC Handbook 1 (1970), CIPAC Handbook 1A (1960), CIPAC Handbook 1A (1983).

- American Society for Testing and Materials (ASTM) Annual book of ASTM Standards.

Data Requirements

The chemical and physical data requirements for the evaluation of technical grade active ingredients and formulated product are detailed in the FAO Guidelines for the Registration and Control of Pesticides.

Some of the basic points to be considered in the assessment of these physical chemical data are discussed below.

Active Ingredient

Identity. Use of internationally recognized common and chemical names, e.g. accepted by the International Organization for Standardization (ISO), the International Union of Pure and Applied Chemistry (IUPAC) and/or Chemical Abstracts, is recommended, as their use provides consistency of the label guarantee and facilitates international trade in pesticides; is consistent with Codex in defining recommended MRLs; and facilitates access to information in published literature and available data on related active ingredients for which toxic microcontaminants have been reported.

Physical/Chemical Properties. Studies on physical/-chemical properties are generally conducted with pure active ingredients (99 per cent or greater) as it is reported by the OECD that even a 1 per cent impurity level may have a major impact upon the results.

These data may be used to predict mobility and degradation in the environment as well as the potential for bioaccumulation, e.g.

- solubility in water and organic solvents (equilibrium concentration in saturated solution at a stated temperature); melting/boiling point which is useful in estimating mobility in the environment, e.g. solubility values >30 ppm indicate that the active ingredient has the potential to leach; and developing isolation/extraction techniques for analytical methods;

- octanol/water partition coefficient (Kow) (ratio of concentration of a pesticide in n-octanol to that in water at equilibrium in dilute solution) which are a prediction of potential for bioaccumulation; and

- hydrolysis and photolysis rates (under stated relevant conditions), vapor pressure, dissociation constants, which are predictive of stability and persistence in the environment.

Manufacturing Methods for the Technical Active Ingredient. A complete description of the manufacturing process with structural formulae, equations at the process, and process flow diagrams is desirable. Quantities or ratios, temperatures, pressures, pH and reaction times should be reviewed when available in order to gain a deeper understanding of the process. In addition, it may be necessary to identify and quantify impurities in the starting materials, e.g. to ensure nitroso-free starting materials.

This information permits comparison with processes for which microcontaminants have been reported and the prediction of the potential for the presence of impurities, microcontaminants and reaction products in the technical material, e.g.:

- permits identification of potential nitrosating agents formed or added in the course of the manufacturing process; and

- permits development of recommendations to alter the manufacturing process to decrease the potential for microcontaminant formation during the course of manufacture.

Due to their confidential nature, details of the manufacturing process are usually difficult to obtain.

Characterization of Technical Active Ingredients. The principal reasons for requiring these data are to identify the essential components to be considered in the evaluation of safety of products to the environment, users and bystanders; to estimate the chemical

equivalence of technical material produced from different sources or via different methods of synthesis; and to ensure that the product used to generate the toxicology and environmental chemistry data are of comparable composition.

- The quality control/quality assurance procedures used to ensure the compliance of the technical material with the stated specifications should be detailed, e.g. what analytical methods are routinely used, and when and how frequently samples are taken (e.g. batch size).

- The composition/specification data should indicate the maximum and minimum levels of active ingredient as well as the maximum levels of impurities and microcontaminants based on the analysis of samples typical of routine production.

  - Specifications should be expressed on the basis of percentage of active ingredient rather than the formulated product. In Canada all impurities which are greater than 0.1 per cent by weight must be identified.

  - If contaminant analysis at 0.1 per cent or greater is not possible, data may be supplemented by a more detailed description of the starting materials and their contaminants and the manufacturing methods.

  - The data provided should be derived from representative samples, e.g. random samples from a number of runs over a period of operation, from a full-scale production facility, not a pilot plant.

- Analytical methods must be sensitive and specific and, where standardized or published methods are not available, a detailed protocol of the method employed should be provided.

  - Data must be accompanied by relevant spectra and chromatograms which demonstrate the sensitivity of the procedure, the absence of interference and clearly identify the active ingredient and impurities, i.e. labeled with respect to retention time and chemical name, and must be accompanied by information on the recovery, precision and accuracy of the methods employed.

Formulated Product

The basic concerns outlined for the technical active product also apply to the formulated product. Information is required on the formulation process, data as to the identity, and the levels of all the components (e.g. active ingredient, inerts and adjuvants), the quality control procedures in place to ensure product integrity, and analytical methods to confirm the label guarantee.

The most important factors to be considered in the evaluation of the formulated product include storage stability and physical and chemical properties.

Storage Stability. This allows evaluators to assess the appropriate shelf life of commercial products and demonstrate that the product is stable for at least one use season. In addition, the potential for the formation of toxic microcontaminants under normal conditions of storage (e.g. nitrosamines, and dimethylamine salt formulations of phenoxyalkanoic acid herbicides) may be determined. Identification of nitrosating agents such as sodium nitrite added as a corrosion inhibitor in metal containers is also possible.

Various degradation products of organophosphorus pesticide formulations including tetra-alkyl phosphate compounds such as tetra-ethyl pyrophosphate (TEPP) should be taken into account when assessing storage stability.

The evaluator must ensure that the studies are conducted under conditions of temperature and humidity which reflect typical storage conditions.

Physical/Chemical Properties. These data are important in drafting appropriate label precautions and recommendations, for example with respect to safe handling and use in consideration of such factors as flammability, explosivity and corrosiveness; to investigate compatibility with other agricultural products (e.g. pesticides and fertilizers) with which they might be mixed; and to develop recommendations to ensure optimum use of the product in the field, e.g. emulsion

stability (for emulsifiable concentrates), wettability and suspensibility (for dispersible powders), the need to have tank contents stirred in the course of application and the importance of water quality used in spray tanks.

"Me-Too" Registrations

By **Bill Murray**
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Detailed knowledge of the composition of a technical product is a prerequisite for the development of regulations concerning "me-too" type registrations. This information is required in order that a meaningful comparison might be made of technical active material produced from different sources.

Chemical Equivalence

Because in its simplest form a technical product may be divided into two components – active ingredient (a.i.) and impurities from the reaction mixture – it should be possible to design a range of variations for both active ingredients and impurities within which products from different sources can be considered chemically equivalent. For example, active ingredients in a technical product are identified qualitatively and are within a set range quantitatively, while impurities in this technical product are more or less the same qualitatively and quantitatively.

In Canada, the following approach is taken to assess the chemical equivalency of different sources of active ingredient.

Analytical Data Required. The determination of chemical equivalency is based on a consideration of the manufacturing processes and the following analytical data produced for each source:

- five (5) batches of technical product analyzed down to 0.1 per cent using specific method(s) but universal detectors;
- if any toxic microcontaminant is present, five (5) batches of technical product analyzed down to 0.1 ppm (detection limits based on a case-by-case basis); and
- ten (10) batches of technical product analyzed for a.i. to define the batch variation.

Table 1. Ranking of Technical Products from New Sources

Criteria	Group AAA	AA	A	B	C	F
Completeness of chemistry data	both	both	both	new s. only	incomp both.	a.i. not same
Production method	same	same	minor	?	?	major
per cent non-identical	< 5%	< 5%	< 5%	?	?	> 5%
Toxic microcontaminant	none	yes	may	may	may	not addressed
Difference in per cent active ingredient	< 5%	> 5%	> 5%	?	?	> 5%

Assessment Criteria. The chemical equivalence of technical products from different sources is assessed according to the following criteria:

- The active ingredients from both sources must be chemically identical.
- Production methods used by both sources must be the same or similar based on an assessment of (i) the raw materials used, process conditions and chemical equations relevant to production of the final technical grade of active ingredient; and (ii) the total percentage of non-identical impurities in both technical products, less than 5 per cent.
- Toxic microcontaminants, if any, in products from the new source should be within batch and analytical variation of those from the registered source, i.e. should not exceed three times the average level found in the registered source.
- The levels of a.i. in the new source should be within 5 per cent of those in the registered source.

The toxicological or bio-equivalence of technical products is not as easily established as is the chemical equivalence. Some of the key points that must be considered in determining what supplementary toxicological data might be required to assess the bio-equivalence of active ingredients from different sources include:

- the differences in the composition of the technical materials, e.g. if the manufacturing method is the same, how do the levels of impurities compare; are they lower or higher?; and, if a different method of manufacture is employed how is the impurity profile changed?
- how similar are the identified impurities to compounds of known toxicological significance, e.g. for which a particular effect or target organ have been identified.

As a first approach, toxicological data generated using representative technical material from the different sources should be considered. The appropriate tests and toxicological endpoints to be considered will be different for each a.i., however a minimum data package consisting of acute, short-term and mutagenicity tests is to be expected. These data on the technical material may be supplemented by data from tests conducted with selected impurities, e.g. principal impurities common to both products or novel or previously unidentified compounds present in the technical material from the new source.

The potential for subtle synergistic or potentiating effects as a result of varying combinations of impurities is difficult to predict. The nature and extent of the "bridging data" required to permit valid assessments of the toxicological equivalence of technical products produced from different sources must be considered on a case-by-case basis.

Example

The following example was encountered recently: a pesticide manufacturer devised a new process technology for Product X and wished to begin marketing the material produced using this new process.

Table 2. Specifications, Technical Material

	Lower Wt %		Lower Wt %	
Active Ingredient	Old	New	Old	New
Product X	95.0	95.0	100.0	95.5

	Upper Limit Wt, per cent	
Impurities	Old Process	New Process
A	4.0	-
B	2.0	3.0
C	3.0	-
D	3.0	-
E	1.0	-
F	1.0	-
G	4.0	-
H	1.0	-
I	2.0	4.0
J	-	0.5*
K	-	0.2*
L	-	0.2*
N	-	2.0
NaCl	5.0	-
H_2SO_4	-	1.0

* levels < 0.1 per cent, in 5 batches of typical technical product;
- not considered significant.

The specifications submitted for the technical materials are listed in Table 2.

Product Chemistry. A complete chemistry data base is available for the technical produced by both processes.

The manufacturing process used in both instances includes a secondary amine intermediate which could theoretically contribute to nitrosamine contamination.

In light of the criteria previously discussed, what would be the appropriate classification for this active ingredient?

Toxicology Data. The toxicological data base generated for the original process material was acceptable by current standards and indicated no concern with respect to teratogenicity, reproductive effects or carcinogenic potential. The supplementary (bridging) data submitted in support of the technical material produced via the new process is listed in Table 3.

The acute oral toxicity profile of both the old and new process materials were determined to be comparable. The introduction of a major new impurity (N) and possible enhanced presence of two impurities common to both processes (B and I) would appear to result in no significant toxicological consequences as determined by the acute lethal, short-term repeated exposure in the rat and mutagenicity studies. It was concluded that the data base currently available for the original process material would support the safety-in-use of the proposed new process material.

Table 3. Supplementary Toxicology Data

Material Tested	Study Type	Species
Technical material: new process old process	acute, oral inhalation	rat
	dermal	rabbit
	eye irritation	rabbit
	dermal irritation	rabbit
	dermal sensitization	guinea pig
	subchronic, oral (4 weeks)	rat
	mutagenicity bacterial point mutation	Ames Test
	mutagenicity mammalian point mutation	CHO/HGPRT Assay
Impurity N: new process	acute oral	rat
Impurities B and I: common both processes	acute oral	rat

The Impact of Toxicity Testing on Registration

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The toxicity testing required in most countries before any pesticide may be marketed is aimed at defining possible hazards to man and the environment that may be encountered during manufacture, transport, storage, use and disposal. Thus the goal of any registration scheme requiring this type of testing is to increase safety, both for humans and beneficial species.

The toxicological parameters needed for decision making are numerous but the most essential include the toxic potential (reversible, irreversible or lethal), the mode of action, and detoxification mechanisms. From these data many practical recommendations can be derived, such as restrictions on use, regime to be adopted at work, protective equipment to be used, suggestion for the techniques to be applied, and principles for storage and safe disposal of unwanted pesticides and used containers. In addition, recommendations can be made on a rational approach to medical examinations of exposed workers and on the treatment needed in case of overexposure.

In most cases toxicity testing is not undertaken in the country where assessment is made; tests are performed in toxicological laboratories which are either independent or are those of chemical manufacturers. To avoid fraud, the precise origin of the data must be identified, and it is advisable to investigate the credibility of the original data thoroughly before accepting, rejecting or requesting duplication of the tests.

The laboratory performing the toxicological studies should generally meet accepted good laboratory practice (GLP) requirements. Before beginning any data analysis, the examiner should be assured that those standards will be met.

Essential Requirements

The minimum studies required for registration purposes vary from country to country but they are essentially as follows:

- acute toxicity tests in mammals;
- subchronic toxicity tests;
- long-term toxicity studies;
- oncogenicity studies;
- reproductive toxicity;
- teratology studies; and
- genotoxicity.

Additional specific studies are, however, mandatory for certain classes of pesticides, e.g. neurotoxicity testing for organophosphorus compounds.

Acute Toxicity Testing. Data from acute toxicity studies permit a ranking of the sensitivity of different species and, at the same time, indicate types of biological activity. However, it should be emphasized that figures indicating LD_{50} or LC_{50} are merely statistical terms needed to quantify lethal response and should, therefore, be considered in conjunction with other parameters. Their significance for safety assessment is frequently overestimated.

Toxicity tests should be performed on technical material and its formulation, as this is the best way to assess the risk to the applicator. However, the percentage of the active material should be known, and data on the impurities, if substantial, should be considered.

In acute oral toxicity tests, LD_{50} values with 95 per cent confidence limits are usually obtained on 4-6 animals per dose level using both sexes of rodent

species. Dermal LD_{50} value is an extremely valuable parameter, as it indicates more directly risks to the user than do oral LD_{50} values.

A number of factors may influence acute toxicity response in a given experimental animal. For example, such factors as age, sex, strain, nutrition, and genetic make-up are known to affect animal response to a pesticide tested. These conditions should therefore be fixed in advance and clearly stated when results are presented.

Subchronic or Short-term Toxicity Tests. These studies last between 14 and 90 days and are designed to provide information on the type of toxic effects, target organs, and reversibility of toxic effects. The parameters monitored include clinical chemistry, haematological effects, organ weights and gross and histopathological examinations. The studies give a good basis for planning the specific studies needed for possible clarification of the mode of action of the active material and potential hazard when used in practice.

Long-term Toxicity Studies. This type of study is designed to determine no-observed-effect-level (NOEL) to provide information relevant to the determination of the safety factor aimed for extrapolation in man. As a rule, technical active material is incorporated into the diet and administered to appropriate groups of experimental animals, usually for a lifetime, using adequate methodologies to calculate actual intake. Choice of species and selection of dose levels are made on the basis of the results of subchronic studies. To determine possible changes in signs and manifestations occurring during the lifetime of experimental animals, non-invasive procedures (bodyweight, food consumption, behavioral observation) should be performed regularly, both on experimental and control groups. Any handling which may produce stress is to be kept at an absolute minimum. Invasive techniques (such as blood sampling) usually use a predesignated group of animals identified for that purpose.

Oncogenicity Studies. This type of study is aimed at assessing the oncogenic potential of a pesticide in experimental animals fed on a diet containing various doses of technical active material. However, it is becoming increasingly difficult to identify a substance as a carcinogen in an oncogenic study, and even more difficult to extrapolate these results to man. Mice appear to differ significantly metabolically from humans and other animals, as evidenced in their particular sensitivity to DDT and other chlorinated hydrocarbons. Also, even firmly established oncogenic potential of a pesticide is only an indication of carcinogenic potential for humans. Consequently, a pesticide for which there is evidence of carcinogenicity in animals should not necessarily be prohibited if there is no evidence of harm to man under its condition of use.

Reproductive Toxicity. These studies are designed to assess a number of aspects of reproduction including fertility, fecundity, parturition, pre-natal and post-natal growth, development and maturation of the offspring, gonadal function, spermatogenic potential and estrous cycles. Most of these parameters are evaluated in the multigeneration studies in which the attention focuses on the conceptus, the neonate and immature animals, because of known variations in toxicity in these stages of development.

When evaluating data from these studies, care should be taken to examine all of the effects, taking into consideration doses applied, intervals between doses, size and number of live pups and lactating capacity of the mother. In case of any abnormality recorded, comparison between the F_0 and F_1 parental animal data may yield useful information on the time at which the effect is initiated.

Teratology Studies. Basically these studies include experiments performed in at least two species, one rodent and one non-rodent, in which experimental animals are fed on a diet throughout the period of gestation. Doses selected should be well below those which are embryotoxic or foetotoxic, as maternal toxicity or embryotoxicity may occur without causing malformation and, vice versa, teratogenic effects may occur without maternal toxicity. Dose-related minor changes should not be ignored as they are of considerable value in assessing whether a low incidence of malformations is compound-related or coincidental. However, there are considerable differences among laboratories both in reporting and in assessing such minor changes.

Genotoxicity. Numerous genotoxicity tests are used today only as supplementary information in supporting evidence for potential carcinogenicity of a pes-

systems, which are indicative of a pesticide-induced change in DNA, may be of great value in the determination of mechanism of action of a potential alkylating agent. However, mutagenicity tests cannot replace a proper oncogenicity study.

Other Studies

Neurotoxicity Studies. Although a number of pesticides are known neurotoxic agents (organophosphates, monomethylcarbamates, pyrethroids), specific studies are required only for organophosphorus compounds, as only this class of pesticides may have the potential to cause delayed neuropathy, a phenomenon entirely separated from their basic biological activity through acetylcholinesterase inhibition. Therefore, with no exception, any organophosphorus compound submitted for registration as a pesticide should be adequately tested on adult hens, according to a well-defined procedure.

Inhibition of Cholinesterases. A number of hazardous pesticides are potential inhibitors of cholinesterases (organophosphates, carbamates) which exert their biological activity, both in insects and humans, through inhibition of acetylcholinesterase at nervous synapses. Butyrylcholinesterase, known also as plasma cholinesterase, plays no role in cholinergic transmission nor in the mechanism of poisoning. Its activity may be taken solely as an indicator of absorption of anticholinesterases. On the other hand, erythrocyte cholinesterase, although playing no role in cholinergic transmission, reflects the acetylcholinesterase activity in the nervous system and therefore its activity may be taken as an indicator of the biochemical effect. The rates of inhibition of various types of cholinesterases determined in an in-vitro system, as well as the rates of the enzyme reactivation are a valuable parameter for assessing untoward effects of overexposure to anticholinesterases. Therefore, submission of these data should be encouraged.

Absorption, Distribution, Excretion and Metabolism. Metabolic and toxicokinetic studies are normally designed to assess the rate of absorption and distribution in the body, possible bioaccumulation, mode and extent of elimination and degradation paths. With these data it is possible to judge whether the compound is absorbed at all, which is the predominant route of absorption and excretion and whether it is degraded. In metabolic studies, special emphasis is given to enzymic catalysis in the degradation processes. These studies may indicate the possible existence of enterohepatic circulation of active material or its metabolite(s) and the existence of the problem of distribution and storage of highly lipophilic substances in various body compartments. Data on absorption, distribution, metabolism and excretion are fundamental for the interpretation of most toxicological studies.

Observation on Man. Whenever available, data on the observation of the effect of pesticides on man obtained either during their production or use should be evaluated with the greatest care. This is particularly justifiable because extrapolation of the data from animal experiments to man is not needed and the safety factor may not be applied. It is equally important to consider the negative results, provided these are correctly recorded.

Decisions which may be Derived from Toxicity Data

Restriction on Use. As already discussed, the acute toxicity by a given route of application makes a basis for classification of the pesticides by hazard, which in turn becomes one of the bases for restrictions on pesticide availability to users. Thus for pesticides belonging to more hazardous groups, special control measures may need to be instituted. Only those who need to use such compounds commercially and who are properly educated, trained and supervised may have access to such hazardous classes of pesticides. For extremely hazardous pesticides, more severe restrictions regarding availability have been introduced in many countries, although implementation has not always been equally successful. Due to known hazards, highly toxic compounds are usually excluded from use in vector control operations. It is also wise to set a toxicity limit for the pesticides to be used indoors.

Regime. Knowledge of the biological effects of the active material, its elimination and detoxification rate, will greatly influence suggestions on the regime at work. For hazardous compounds, shorter working hours may be applicable with specific training and stricter supervision suggested. Based on the toxicological characteristics of a given compound, certain

techniques of application may be suggested and others discouraged. Since a combined effect of two or more pesticides may be more than additional, it is important in these cases to suggest a less harmful sequence of exposure. For example, if an organophosphorus compound and a monomethylcarbamate are to be sprayed in sequence, it is better to start with the carbamate.

Protective Measures. On the basis of the knowledge gained from toxicity testing, protective measures to be installed or used for any handling of a pesticidal preparation can be scientifically selected. Thus, understanding the relation of acute toxicity by different routes of administration will indicate whether dermal or oral route of entry are posing a greater risk and whether the respiratory tract should also be protected.

Exaggeration in recommending protective measures may achieve a contrary effect, particularly if local habits, climate and the feasibility of the implementation of such protective measures are not taken into account.

Medical Surveillance. If the mode of action is understood, instructions regarding pre-employment and periodic medical examinations may be more specific. Pre-existing medical conditions that may place the exposed worker at increased risk may be listed. The signs and symptoms that may appear in workers handling a pesticide are more easily recognized and associated with overexposure. In addition, a therapeutic procedure may be directed toward the impaired system and need not be only symptomatic. An understanding of the biological activity of an active ingredient is a basis for any rational therapeutic procedure as well as for the development of specific antidotes.

The impairment of a system may serve as a guide to assess the extent of exposure. Thus in the case of anticholinesterase compounds, their inhibitory effect on cholinesterases can easily be measured. The knowledge of the inhibitory properties of a particular anticholinesterase pesticide will help in the understanding of the significance of enzyme activity in the blood, which itself reflects biochemical lesion in the nervous tissue responsible for signs and symptoms of overexposure to this class of pesticide. An equivalent degree of cholinesterase inhibition by a monomethylcarbamate insecticide will have a different prognostic meaning from the same degree of enzyme inhibition by an organophosphorus compound. Similar knowledge helps the establishment of sound systems for monitoring exposure to a given group of pesticides in determining whether the most appropriate way of monitoring exposure is measuring pesticides in the body, determining excretion of a metabolite, or identifying the effects produced.

Efficacy Data

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One of the primary objectives for controlling pesticides is to ensure that the product is effective for the control of the target pest while causing little or no deleterious effect to man, nontarget organisms and the environment as a whole.

Registration authorities must assess the efficacy and crop safety of new pesticides to evaluate the benefits to be obtained from their use. These benefits must be weighed against the potential hazards from the introduction of a new compound, and the decision to grant registration must incorporate this benefit/risk analysis. As formulation type and application method are important factors in the assessment of efficacy, a short summary of these factors is included here.

Formulation Types

The technical materials or active ingredients of pesticides must be formulated to usable forms. Active ingredients are blended with a number of additives, each of which has its own characteristics and is incorporated into the formulation for a special purpose. The ingredients of a formulation consist of:

- an active ingredient – the portion of the pesticide that contains the actual toxicant; its properties influence the choice of other ingredients;

- solvents – liquids such as water, kerosene or oil that dissolve a pesticide and form a solution;

- carriers – these are generally the inert solid ingredients used to dilute the pesticide, usually in dry formulations such as dusts, dispersible powders and granules;

- surface active agents, also called surfactants – an important group of chemicals to which compounds such as emulsifying agents or emulsifiers, wetting agents, dispersing agents, antifoaming agents and spreading agents belong; and

- special additives which may be incorporated in a formulation, or added as tank-mixes for specific purposes. These may consist of stabilizers to reduce deterioration; synergist to enhance the activity of insecticides; wetters to wet crops – in particular those with waxy surfaces; oils to enhance the biological activity of the pesticide; defoamers to reduce foaming especially during mixing; thickeners to act as antidrift agents and to reduce runoff from plant surfaces; and coloring agents to reduce the possibility of accidents.

There are several types of pesticide formulations available. The term formulation is defined in the International Code of Conduct as the combination of various ingredients designed to render the product useful and effective for the purpose claimed; the form of the pesticide as purchased by users. Commonly used formulations are:

- water dispersible powder (WDP);
- emulsifiable concentrate (EC);
- suspension concentrate;
- solution concentrate (SC);
- water soluble powder (WSP);
- granules (G);
- dusts (D);
- baits (B); and
- controlled release formulations.

Application Techniques

While the application of granular pesticide formulations is relatively simple, application of other formulations and foliar sprays requires the use of more sophisticated spray equipment. The types of sprayers commonly used are discussed below.

Hand-operated sprayers with hydraulic pumps include the following:

- Trombone (or slide-action) sprayers are the simplest and cheapest type of sprayers available. The pump may be single action or double action. The chemical mixture is drawn from a separate container. The sprayers are usually fitted with a cone-type nozzle.

- In stirrup or bucket-pump sprayers, the pump is placed in a container of the chemical mixture. One operator carries out the pumping action while the other does the spraying. The spray is continuous as long as pumping is continued.

- With shoulder-pump sprayers, the tank is carried by a single strap hung over one shoulder. A pressure vessel enclosing a pump cylinder is fitted inside the tank and the sprayer is pumped with one hand while the lance and nozzle is held in the other.

- Lever-operated knapsack sprayers have a tank of about 10-20 liters carried on the back of the operator like a knapsack. They also consist of a hand operated pump, a pressure vessel and a lance with one or more nozzles.

- Compression or pneumatic sprayers may be hand-carried and are of 1 to 5-liter capacity, or shoulder slung or knapsack type of 12-liter capacity. The tank is cylindrical with a plunger pump, and the whole tank is air-tight and acts as a pressure vessel.

Motorized knapsack mistblowers consist of a 10-liter capacity tank situated above the engine where the fan produces a high velocity air blast which is directed through a flexible hose to the nozzle.

Mistblowers can be converted from liquid to solid application by attaching a tank designed for granules and dusts or modifying the tank for liquid. Nozzles for dust application may be open tubes of up to 2 meters in length at the end of the air hose, or long flexible polythene tubes with many holes, up to 30 meters long and carried by two operators. Granules may be dispersed through a spreader at the end of the air hose.

Hand-carried spinning disc sprayers are lightweight sprayers with a plastic spray-head equipped with an electrical DC motor and rotating disc(s), a screw-on bottle as a spray reservoir and a plastic tube handle holding one or two sets of eight batteries. The size of the droplets is controlled by the rotational speed of the disc and the volume of the spray fed to the disc.

Hand-operated rotary dusters consist of a hopper and a blower driven by a rotating crank. The dust flow into the blower can be regulated and is blown out through the discharge pipe as a uniform cloud of dust.

Nozzles. The nozzles of hand-operated sprayers belong to the hydraulic energy type and are distinguished as:

- solid-cone nozzles which spray a conical pattern of evenly distributed droplets with the center being filled. These are suitable for spraying field crops for insect and disease control.

- hollow-cone type nozzles which produce a circular pattern with almost no spray droplets in the center. These are suited for insect, disease and weed control spraying.

- regular flat-fan nozzles which spray a narrow oval pattern. These are suited for application of herbicides and for spraying walls for vector control.

- even flat-fan nozzles with an even spray tip which provide uniform distribution across the entire width of the spray band. These are suitable for tank spraying in pre-emergence and post-emergence herbicide applications and for the spraying of walls.

- impact nozzles (also called anvil or flood nozzles) which produce a wide-angle flat-fan, rather uneven spray pattern. These are operated at low pressure for pre-emergemce and post-emergence herbicide and liquid fertilizer applications.

Efficacy Assessment Procedures

Efficacy is the ability of a pesticide to fulfill the claims made for it on the proposed label. In practice, efficacy is tested on one or several specific host/pest combinations, for each of which registration is sought.

Efficacy data provide the registration authority with information on the effectiveness of a particular pesticide product against a specific pest, and the conditions under which the test was conducted. It thus provides essential data for benefit/risk assessment.

The sources of information may be trials carried out by the applicant to register a pesticide or information published in scientific journals. The preferred source is specific evaluation using acceptable efficacy test protocols such as those developed by the European and Mediterranean Plant Protection Organization (EPPO), the International Rice Research Institute (IRRI), FAO or other agencies recognized by the registration authority.

The quality of data would be based on the acceptable test protocols provided all the requirements are adhered to as closely as possible. The method of reporting should include the various topics stipulated although the raw data must be kept available if the registration authority wishes to view it.

The principles to be followed are as stipulated in the efficacy test protocols and FAO Guidelines. Pesticides must be evaluated under conditions similar to those under which the chemical is to be recommended for use. Cultural conditions in the trial should conform with local agricultural practice. Trials should be carried out in different regions if distinct environmental conditions exist and preferably in different seasons.

Effectiveness of a pesticide may be determined by the reduction of pest population, disease incidence, or increase in yield of the crop. The efficacy data of the test product must show that it is statistically equal if not more effective than the reference pesticide (i.e. the currently recommended pesticide for control of the pest) included in the evaluation.

Label claims must be based on the efficacy data and such claims should only be permitted on economically important pests under local conditions, and where the data is statistically conclusive that the product is effective.

Only basic requirements of a general nature can be provided on the design of the efficacy trial program. The design of any experiment, required plot size and the methods for the evaluation have to be adapted to the specific crop/pest combination and the agricultural practices concerned. Several factors must be taken into consideration in the design of individual trials such as uniformity in soil conditions; preceding crop condition; edge effects; life history and behavior of the pest; timing of the application; mode of application of the pesticide; layout of the trial which allows for statistical analysis; plot size and shape; number of replications depending on the variance; and number of treatments.

A reference product should be included in the trial which must be a registered product currently recommended against the particular pest. The pesticide must be applied with the type of equipment in current use, at the dosage recommended on the proposed label. The trials in this program should be designed, the pesticide concerned applied, and results evaluated in such a manner that a reliable judgment can be made on the efficacy of the pesticide under a range of conditions. The test program for a pesticide under study should, where possible, include supervised trials on main cultivars currently grown in regions where the use of the product is intended.

In reporting the trials, the presentation of results should be standardized to facilitate understanding of the trial results, and all data obtained from the analysis of single samples should be recorded. The report should provide the following:

- name of the experimenter and organization responsible for the trial;
- objective and location of the trial;
- chemical name and formulation;
- pest against which tested;
- crops and cultivars;

- plant growth stage;
- soil type;
- experimental design, size and number of plots treated;
- application dates and rates;
- application method and equipment;
- volume of spray liquid or other carrier (types);
- weather conditions during and after treatment;
- treatment of the plots with other crop protecting materials, fertilizers and other products;
- dates and method(s) of assessment (may include pictures of symptoms);
- size and frequency of sampling;
- quantity and quality of the yield of the harvested crop;
- any results on crop safety including intervals to be observed to avoid phytotoxic effects;
- data assessment including significance; and finally
- interpretation and discussion on the results of the experiment in comparison with similar trials.

Residue Data

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Reliable data on residues of pesticides in treated crops are normally required for registration. These residue data are used to estimate the exposure of the general population to pesticide residue limits (MRLs, i.e. the maximum concentration of a pesticide residue legally permitted in or on a food commodity treated according to good agricultural practice).

The evaluation of residue data generated in support of a proposed MRL must take into account information on the chemical and physical properties of the technical and formulated product, as well as metabolism and degradation data, the design and sampling of the field trials, the analytical methods employed and a reliable assessment of the potential exposure to the residues.

Data Requirements

The residue chemistry data considered in the estimation of an MRL must address two basic questions, i.e. what is the nature of the chemical residue and how much is present. The data required to answer these questions may be divided into three main areas:

- metabolism – identification and distribution of the principal components of the terminal residues in treated crops and livestock;
- analytical methods – quantification of the principal components of the terminal residue in treated food crops at harvest, or livestock at slaughter; and
- magnitude of the residue – evaluation of data from supervised residue trials conducted according to the proposed label recommendations under representative field conditions in different geographical locations. These data form the basis for the elaboration of national MRLs.

Data Assessment

The basic points for consideration in the assessment of the submitted data should include, but not be limited to, metabolism, analytical methods, and residue trials. These are discussed below.

Metabolism

Most pesticides undergo significant transformations following application. The composition of the terminal residues must be determined before the analytical methods, residue levels, or toxicology data may be developed. Data on metabolism are used to confirm that the residue data developed in the supervised field trials have taken into account the distribution and composition of the terminal residue.

Studies are generally conducted with radio labeled analogues (^{14}C) in representative plant and animal species in a manner approximating, as closely as possible, expected use conditions or label recommendations.

The main points derived from this information include:

- the nature of the metabolic pathway and the identification of interim and terminal metabolites;
- the distribution of the metabolic products in the edible portion of treated crops or livestock; and
- the changes in the composition of the residue with time, and the composition of the terminal residue at harvest or slaughter.

Residue Definition. The decision as to which metabolites and/or degradation products to include in the

terminal residue definition is a function of the quantity and toxicological significance of each terminal metabolite.

Residue Expression. Residues are generally expressed in one of three possible ways:

- parent compound only:
  - metabolites are either not present or are not at significant levels;
  - analytical method measures the total residue as a single compound which may be expressed numerically as a parent compound;
  - metabolites of significance are present and may be measured separately by the analytical method used. The residue may be expressed additively as parent compound, with recalculation for differences in molecular weight only when the differences are substantial (e.g. greater than 20 per cent), e.g. aldicarb and etrmphos;

- as a single metabolite or alteration product:
  - residues are quantitatively converted to another chemical entity, e.g. dithiocarbamates to carbon disulphide;
  - analytical method measures the total residue as a single metabolite, e.g. benomyl, thiophanate-methyl as carbendazim;
  - metabolites of significance are present and are measured separately by the analytical method employed. The residue may be expressed additively in terms of a metabolite with recalculation for differences in molecular weight only when the differences are substantial (e.g. greater than 20 per cent), e.g. azocyclotin as cyhexatin.

- residues expressed as parent and metabolites separately:
  - metabolites are known to be present in significant amounts and the analytical method measures each component of the terminal residue separately;
  - highly toxic metabolites/degradation products are generally listed separately, e.g. ethylene thiourea.

Overall, each of the metabolites/degradation products included in the residue definition should be detailed in lists of MRLs regardless of the method of determination.

The current trend within the Codex and some countries to identify a single component of the terminal residue as an indicator compound for the development/definition of maximum residue limits is different from the approach taken in Canada where consideration is given to the composition of the total terminal residue.

Analytical Methods

Careful consideration must be given to the analytical methodology used to generate residue data. There are a number of manuals and guides which detail acceptable methods for the analysis of pesticide residues as well as protocols for their development. (See p. 130, References.)

The method must reliably quantify in a manner which can be replicated, all significant components of the terminal residue at levels expected to occur in the field. Some of the basic points to consider during the assessment of an appropriate analytical method are outlined below.

- The extraction and separation techniques should be similar to those identified in the metabolism studies as being necessary to release and extract the principal components of the terminal residue.

- The method must be validated for each commodity with extraction recovery data over a range of values which include the expected residue levels:
  - the method of fortification should be detailed, e.g. fortified samples should be taken through the entire analytical procedure;
  - the method used to quantify residue levels should be detailed. The analytical report should be accompanied by sample calculations and relevant supporting data, e.g. data used to construct calibration curves; and
  - copies of representative chromatograms and/or spectra should be provided to

indicate that the extracts are free of extraneous coextracants, e.g. reports should include representative traces of solvent blank, control samples, standards, and fortified samples.

- The analytical methodology should use and specify reagents and the apparatus which are expected to be generally available, such as:
  - methods which employ gas chromatography (GC) or high pressure liquid chromatography (HPLC): these are generally preferred; and
  - analytical procedures which are clearly documented in sufficient detail to permit implementation by a competent chemist.

Residue Trials

It is not possible to carry out sufficient trials to cover all the various conditions of climate, soil and farming practices under which a pesticide may be used on a crop. Thus study design should be directed towards the determination and evaluation of the conditions and factors which lead to the highest residue levels following recommended use patterns, e.g. highest application rates, maximum number of applications and the shortest time between the last application and harvest.

A comprehensive protocol for conducting residue trials has been published separately by FAO, GIFAP and IUPAC at different times. This protocol was reviewed and updated recently and a revised version is expected to be available in the near future.

Some of the most important factors to be considered in the assessment of field trial data are discussed below.

The conditions of the trial should reflect in every way the label recommendations, including formulation and method of application; maximum rate and frequency of application; and minimum interval between last application and harvest. Plot sizes employed should be sufficient to allow the use of equipment and procedures that reflect expected commercial practice and permit collection of representative crop samples.

The climatic conditions over the course of the trial should be documented to allow comparison with local conditions and perhaps to explain anomalous results.

The number of sites and samples needed depends on the range of conditions to be covered.

- Residue data from several different trial sites are required to confirm that residue patterns hold for all regions in which the product is likely to be used.

- In general, additional samples from a number of different sites are preferable to further sampling in a given site since the variations in residue levels between replicates at individual sites are small compared to those found in data from different sites.

- Consideration of data from residue trials conducted over at least two growing seasons is recommended.

Residue decline studies in which treated commodities are sampled at intervals between the last application and harvest are desirable. These data provide information on the effect of pre-harvest interval on levels of terminal residues.

Detailed information is required on how and when the product was sampled and how samples were handled prior to analysis.

- Samples should be kept frozen (-20°C) between harvest and analysis.

- Storage stability data for residues in treated commodities should be requested if samples are stored prior to analysis.

- Details of the manner in which samples were prepared for analysis should be provided, e.g. removal of loose soil and damaged outer leaves.

- The portion of the commodity analyzed should reflect that to which the MRL is expected to apply.

The analytical method used should be clearly presented and recovery data validating the sensitivity/reliability of the procedure should accompany each set of trial data.

Data on background levels in untreated samples and documentation as to whether results have been corrected for background and/or recovery efficiency should be provided.

Summary

A residue trial report should clearly provide but not necessarily be limited to the following information:

1. chemical name and formulation of the test material;
2. crops or cultivars studied;
3. stage of growth at application;
4. location of trial;
5. experimental design, size and number of plots treated;
6. application rates and dates;
7. application method and equipment;
8. volume of spray liquid or other carrier (type);
9. weather conditions during and after treatment;
10. treatment of the crops with other control products;
11. size, frequency and dates of sampling;
12. treatment of samples prior to analysis;
13. dates of analysis;
14. definition of residue measured;
15. analytical method employed;
16. validation data for analytical method used, supported by copies of representative chromatograms; and
17. a statement as to whether data are corrected for recovery efficiency or background levels.

Example

Box 2 shows an actual residue trial report to which the above 17 points have been applied. The example is taken from Pesticide Research Reports, an annual report which compiles trials conducted by federal and provincial researchers in Canada, company and university researchers and private consultants. The proposed use is Ambush 500 EC, Cymbush 250 EC, Belmark 300 EC, Decis 2.5 EC on celery and lettuce in Canada.

The following list shows the points missed and their relevancy:

3. crop stage of growth at application;
6. indicates three applications yet only two dates are specified;
9. no summary of weather conditions before or after treatment;
10. no reference made to treatment of plots with other crop protecting materials;
11. no information on the size and number of samples (may also indicate number 4);
12. treatment of samples prior to analysis is unknown;
13. the interval between harvest and analysis cannot be determined;
14. the composition of the residue is not defined;
15. analytical method is not indicated;
16. no validation data are provided to support the analytical method; and
17. no indication of whether data are corrected for recovery or background interference, i.e. are these average values for replicate samples.

Evaluation of Data

The lack of any supporting data with respect to the reliability of the analytical methodology, nature of the terminal residue measured or handling of samples between harvest and analysis makes the evaluation of these data difficult. Some general observations that may be made include the following:

- Initial residues of the four compounds reflect the relative rates of application on both celery and lettuce.

- Low level residues on celery are persistent for at least fifteen days following treatment with permethrin, cypermethrin and fenvalerate while residues of deltamethrin are nondetectable within ten days, primarily due to the lower rate of application. The reason for the variability of the reported residue levels is uncertain: it may be due to the analytical method, the sampling techniques used or handling treatment of the samples prior to analysis.

Box 2. Pesticide Research Report

Crop: Celery (var. Stokes 1mp, Utah 52-70) (2)
Lettuce (var. Ithaca)

Title: MINOR CROPS, INSECTICIDE RESIDUES

Materials: AMBUSH 500 EC (permethrin),
CYMBUSH 250 EC (cypermethrin),
BELMARK 300 EC (fenvalerate),
DECIS 2.5 EC (deltamethrin).

Methods: The tests were done at the Holland Marsh (4) on muck soil. Eight-row plots, 15 meters long were planted with lettuce. Six-row plots, 15 meters (5) long were transplanted with celery. The (7) treatments were applied at a rate of 550 liters (8) per ha, with a tractor-counted sprayer. Four pyrethroids were combined and applied on celery and lettuce twice, at weekly intervals at two rates of application. With all treatments, the crops were treated prior to harvest and sampled at various intervals during harvest maturity. Each treatment was replicated four times. Samples were analyzed for residue (methods of analyses available on request).

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Results: Data are presented in Tables 1 and 2.

Conclusions: Initial residues of the four pyrethroids reflected relative rates of application. Residues, as a percentage of plant weight, declined at nearly the same rates with all of the insecticides tested with the possible exception of deltamethrin. With this material, initial residues were low (reflecting a low rate of application) and these declined to nondetectable levels in about 10 days.

Table 1. Residue of pyrethroids in celery when the insecticides were applied twice at weekly intervals prior to harvest[a]

		Residues in celery (mg/kg) (6) Days after 3rd application					
Treatment	Rate (kg a.i./ha)	0	2	3	10	15	20
permethrin	0.05	0.059	0.089	0.061	0.025	0.033	0.009
	0.10	0.173	0.132	0.100	0.037	0.091	0.012
cypermethrin	0.035	0.066	0.115	0.066	60.026	0.033	0.007
	0.070	0.211	0.181	0.127	0.022	0.102	0.012
fenvalerate	0.020	0.040	0.072	0.048	0.018	0.029	0.007
	0.040	0.122	0.108	0.084	0.027	0.082	0.010
deltamethrin	0.005	0.014	0.027	0.013	ND[b]	ND	ND
	0.010	0.041	0.038	0.027	ND	0.002	ND

a/ Treated 4 and 11 August 1987; b/ ND = not detected; level of detection 0.005 mg/kg.

Table 2. Residue of pyrethroids in lettuce when the insecticides were applied twice at weekly intervals prior to harvest[a]

		Residues in celery (mg/kg) Days after 3rd application					
Treatment	Rate (kg a.i./ha)	0	2	3	10	15	20
permethrin	0.05	0.314	0.328	0.093	0.058	0.018	ND[b]
	0.10	1.115	0.323	0.148	0.088	0.042	ND
cypermethrin	0.035	0.315	0.355	0.104	0.091	0.009	ND
	0.070	1.175	0.378	0.163	0.089	0.024	ND
fenvalerate	0.020	0.770	0.178	0.053	0.027	0.008	ND
	0.040	0.663	0.298	0.095	0.060	0.023	ND
deltamethrin	0.005	0.138	0.029	0.016	ND	ND	ND
	0.010	0.345	0.146	0.035	0.013	ND	ND

a/ Treated 13 and 21 July 1987; b/ ND = not detected; level of detection 0.005 mg/kg.

- Residues on lettuce are seen to decline more rapidly than those on celery and are nondetectable within 20 days of application. This decline is most likely a function of growth dilution rather than an increased rate of degradation.

Issues Considered in Estimating MRLs

Safety Assessment of Proposed MRLs. Once maximum residue limits have been determined from the relevant trial data an estimate is made of the potential residue intake by combining these data with consumption data for specific food commodities. This estimate of total exposure is called the theoretical daily intake (TDI). This calculated TDI is compared to the acceptable daily intake derived from an assessment of the available toxicological data. It is understood that the TDI figure is a gross overestimate of the true pesticide residue intake, however it is recognized as a valid screening procedure. If the TDI is less than or equal to the ADI then the proposed maximum residue limits are considered to be acceptable and further consideration of the potential intake is not warranted. If the TDI exceeds the ADI, further information is considered in order to calculate an estimated daily intake (EDI) based on residues in food at the point of consumption. This may include studies investigating the effects of storage and processing on pesticide residues and analytical data reflecting actual residue levels remaining on foods as consumed.

A recent publication of WHO (1989) details the factors which should be considered in estimating dietary intakes of pesticide residues.

Impact of National MRLs on Trade. In developing national MRLs consideration should be given to the residue levels which result from GAP on imported commodities. Canada routinely requests the use patterns and supporting residue data for the US and other countries from whom it imports significant quantities of food. These data form the basis for the establishment of import tolerances for commodities, e.g. citrus and tropical fruit not grown in Canada. These data may also be used in certain situations to adjust Canada's domestic MRLs to accommodate higher residue levels in other countries if this is toxicologically acceptable.

Monitoring and Enforcement of MRLs. The setting of maximum residue limits would be of little value unless some attempt was made to ensure that foods offered for sale are in compliance with these requirements. As it is not feasible to conduct separate analyses for each active ingredient, some consideration must be given as to whether newly established MRLs may be accommodated by existing analytical methodology.

In situations where residues are quantified with analytical methods that degrade residue to a common moiety, attention must be given as to their utility in monitoring activities. In order that an unequivocal identification of a residue may be made in these situations, it may be necessary to consider different methods for the enforcement of MRLs from those used to develop the field trial, e.g. compounds degraded to 3, 5-dichloroaniline such as vinclozolin, iprodione and procymidone.

MRLs in the Context of an Overall Regulatory Assessment. MRLs are not established in isolation but are part of a larger evaluation which must necessarily consider additional factors such as environmental effects and occupational exposure. It is important then, that before an MRL is established, the product in question be considered acceptable following assessment of its potential environmental effects and that it can be used in a safe manner by farmers.

Supervised Residue Trials Conducted at the National Level

By **Geoff Willis**
Chairman, GIFAP Residue Committee

Supervised residue trials conducted at the national level provide data for establishing MRLs at the national and international levels, and allow countries to assess whether the residues deriving from a use or proposed use of a pesticide in an exporting country will lead to residues consistent with the MRLs set by an importing country. Also, within certain limits, data derived from supervised residue trials can be used to predict daily intakes of pesticide residues.

Maximum Residue Limits

MRLs are trading standards which are applied at the point at which a commodity, produced domestically or imported, enters trade. They are expressed in mg of residue/kg of commodity.

If a pesticide is used as recommended, the resulting residues in the crop should not exceed the MRL value which was set for that individual pesticide in individual food and feed items (or groups of food/feed items). MRLs are based on the results of pre-marketing supervised residue trials. MRL values are set at the upper end of the range of residue figures determined in the supervised trials; such trials should reflect good agricultural practices.

As conditions of climate, soil and farming practice differ, the MRLs for a given compound will often differ on different crops, depending upon the nature of the crop and the times of spraying. The MRLs for different pesticides on the same crop can also differ, depending on the different use recommendations between products.

Acceptable Daily Intake

Residue levels in food consumed must, of course, be acceptable toxicologically. Therefore, an estimate is required of a level of pesticide residue intake below which the risk to health is too small to be of concern. This level of intake is normally referred to as the acceptable daily intake (ADI), which is the amount of a chemical which can be consumed every day over an individual's lifetime with the practical certainty, on the basis of all known facts, that no harm will result.

ADIs are derived from the results of studies with laboratory animals. The studies encompass an assessment of possible carcinogenic, mutagenic and teratogenic potential. The possibility that a residue might be neurotoxic or have a reproductive effect is also considered. The intake causing no observed toxicologically-significant effect in animals, when given daily over their life span, is determined. The ADIs are then derived by the application of generous safety factors (usually 100) to the no-observed-adverse-effect level (NOAEL) in the most sensitive species studied. Smaller safety factors have been used when relevant data are available on humans. Conversely, a larger margin of safety can be used where toxicological findings suggest that it would be prudent to do so.

The ADI value is expressed in terms of milligrams of the residue ingested per kilogram of body weight.

Unlike the MRL, which applies in trade, the ADI is a health standard applied at the point of consumption.

Use of Data from Supervised Trials in Predicting the Daily Intake of Pesticide Residues

With certain limitations, residue data from supervised trials can be used to predict daily intakes of pesticide residues; such predictions allow a comparison with the ADI.[1]

If the daily human consumption of a crop is known, and the MRL value for that crop is used, it is possible to calculate a theoretical maximum daily intake of the residue by humans eating that crop. Of course, the different food consumption patterns between different groups within a community must be taken into account. The process can be repeated for each crop, and the resulting intakes summed, to produce a figure for the theoretical maximum daily intake (TMDI). While the TMDI is a gross overestimate of the potential daily intake, it is useful as a screening tool in those situations, which are many, where the TMDI does not exceed the ADI. In such situations, using even the most extreme estimates, it is predicted that actual intake will not exceed the ADI.

On the other hand, in those cases where the TMDI exceeds the ADI, it is appropriate to generate a more realistic estimate of intake by using more realistic residue values. This estimate may be derived from data on residues in commodities after commercial processing, domestic preparation and cooking. However, even when more realistic assumptions of likely residue levels in individual commodities are used in place of the MRL values, these calculations still tend to overestimate the extent to which residues will appear in food in practice.

A comparison of potential intakes calculated in these ways with the ADI value is useful as a coarse screening method of demonstrating that residues in food are unlikely to be a source of toxicological concern. However, such calculations can not, **and must not**, be used as a basis for concluding that an ADI will be exceeded and, thus, for denying the registration of a proposed use and/or for rejecting a proposed MRL value. In those cases where the possibility arises that the TMDI may exceed the ADI, the compound should be considered for inclusion in monitoring programs and dietary intake studies which many governments perform. Only direct determinations of residue levels at the point of consumption can be used to demonstrate that an ADI is being exceeded.

As is shown in Table 4, in practice, the levels of intake are invariably much lower than might have been expected in theory. The various reasons for this include the following:

Table 4. Comparisons of Actual Daily Intakes, Theoretical Daily Intakes and Acceptable Daily Intakes: USA, 1974-1976

Pesticide	Theoretical Potential Daily Intake (mg per person per day)	Actual Daily Intake (mg per person per day)	ADI[a] Applied to a 60-kg Person (mg per person per day)
Captain	18	0.001	6
Methoxychlor	10	0.0004	6
Dieldrin	0.06	0.002	0.006
Parathion	0.8	0.00006	0.3
Carbaryl	5.6	0.001	0.6

a/ All ADI figures are from the Joint Meeting on Pesticide Residues (JMPR) evaluations.
Source: J.A.R. Bates and S. Gorbach, (1982) J. Pure Appli. Chem., 54, 1361.

1/ Guidelines for conducting such predictions are available in the form of WHO Guidelines for Predicting Dietary Intakes of Pesticide Residues, 1989.

- Each crop is not treated completely with each pesticide.

- Pesticides are not always applied at the highest recommended application rate or at the latest time before harvest. The use of the MRL value in TMDI calculations overestimates the residue levels which will normally occur.

- A large proportion of the residue in the raw agricultural commodity can be discarded with inedible portions.

- Residue levels often dissipate further during storage, transport, commercial processing and during domestic preparation and cooking.

- It is unlikely that a person will consume in the same day all the commodities on which the product is registered.

Harmonization of MRLs Between Countries

In the mid-1950s, countries began to legislate for standards of assessing pesticide residues in food/feed, and began using MRLs. Problems arose, however, as a number of separate national MRL regulations were developed. A national MRL was usually applied both to domestically produced food and to imported food commodities. While more than 95 per cent of exported food consignments studied normally comply with the MRLs prevailing in the importing country, if an exporting country and an importing country have established MRLs at different levels, trade obstacles could occur.

Because of the potential for such problems, a joint meeting between the FAO Panel of Experts on the Use of Pesticides in Agriculture and the WHO Expert Committee on Pesticide Residues was convened in 1961. The purpose of this meeting was to consider a program to study the principles for establishing MRLs for pesticide residues in food, bearing in mind the aspect of consumer safety. The first regular working session of the FAO and WHO experts took place in 1963. Since 1965, meetings – now known as the Joint Meeting on Pesticide Residues (JMPR) – have convened annually.

The WHO Expert Group of JMPR considers biochemical and toxicological data which are available for review. It estimates ADI figures for each individual pesticide under consideration. The FAO Panel of Experts of the JMPR considers the available data on recognized use patterns and resulting residues. From these, it estimates MRLs for each individual pesticide under consideration on individual (or groups of) food and feed commodities. These MRL recommendations take into account the recognized worldwide use patterns, which, as mentioned previously, can differ between countries. The FAO Panel also reviews recommended methods of pesticide residue analysis suitable for regulatory use in enforcing MRLs.

The results of each Group's deliberations, as well as the information reviewed to reach these conclusions, are published by FAO.

Parallel with the JMPR, the Codex Alimentarius Commission was established in 1963 under the auspices of FAO and WHO. The Commission is charged with establishing food standards. It comprises a number of Committees dealing with standards for individual food groups and for more general subjects related to food. The Netherlands has taken responsibility for the organization and accommodation of the regular sessions of the Codex Committee on Pesticide Residues (CCPR).

The CCPR consists of delegates from member countries; about 40 countries usually attend. Their primary objective is to reach agreement on internationally acceptable maximum limits for pesticide residues in food and feed commodities moving in international trade. The MRL proposals discussed by CCPR are those which have been developed by JMPR. In dealing with these proposals, CCPR follows a step-by-step procedure. Proposals for maximum residue limits which have reached the penultimate procedural step are regularly published by FAO and WHO in their series "Recommended international maximum limits for pesticide residues". This is the stage at which maximum residue limits are formally recommended by the Codex Alimentarius Commission to governments for acceptance, as CXLs.

Supervised Trials in Developing Countries to Produce Data for Evaluation by JMPR and CCPR

Not all pesticides, or all uses of pesticides, have been reviewed by JMPR. There are legitimate reasons for this. For example, JMPR is concerned with

compounds which leave measurable residues in commodities moving in international trade. If the uses of a product do not leave detectable residues, the pesticide does not, in principle, qualify for a JMPR evaluation: there should be no problems in trade resulting from residues.

Should a government foresee a need for a compound to receive a JMPR evaluation, GIFAP recommends that the basic manufacturer be approached first, to ascertain the availability of data for submission to the JMPR. If a manufacturer is unable to submit such data, he may nevertheless be able to help resolve problems in trade by applying for MRLs in specific importing countries, as part of the registration process.

Where a pesticide has received a JMPR evaluation but residue data on a specific crop were not evaluated, it may be productive for governments to discuss with basic manufacturers the possibility of the company analyzing in its laboratories crops which have been treated in good quality, government supervised field trials, to generate residue data for submission to the JMPR and/or governments of importing countries. Detailed discussions on the design and conduct of the studies are important before any such program is initiated.

Finally, industry has an active part to play in the process of harmonizing MRLs. Where MRLs are being proposed in any given country, GIFAP urges the local companies to discuss with their head offices, or the basic manufacturer, the values being considered. Personnel at the head office will usually know the full spectrum of international need. They should also be able to make recommendations which could assist in the process of national registration, as well as of harmonization between governments during the Codex procedure.

Ecological Effects Data - Hazard Assessment

By **Henry T. Craven**
Supervisory Biologist, Ecological Effects Branch, Environmental Fate and Effects Division, US EPA

The Ecological Effects Branch (EEB) of the US EPA provides the Office of Pesticides Programs (OPP) with a nonhuman, nontarget organism (both terrestrial and aquatic) hazard assessment. There are three basic elements of hazard assessment: (i) determination of toxicity; (ii) determination of fate and exposure to nontargets; and (iii) integration of these two into a determination of hazard. Ecological hazard assessment from the use of pesticides may be defined as the method for estimating the likelihood that adverse effects will occur, are occurring, or have occurred. Adverse effects may be defined, for example, as reductions in populations of nontarget organisms due to acute, chronic, and reproductive effects, or disruption in community and ecosystem level functions.

Data from the following six categories are integrated into a hazard assessment (see Figure 2): use practice; product chemistry; environmental chemistry; residue chemistry; toxicology and nontarget organism ecotoxicology; and natural history. The EEB's findings pertaining to need for additional testing and precautionary label statements accompany a hazard assessment.

Nontarget Organism Ecotoxicology Data Requirements

The EEB uses a tiered scheme of studies to ensure that the appropriate data are available for the construction of a hazard assessment. Inherent in this scheme is the notion that higher-tier studies are required depending upon the results of lower-tier studies. Two test schemes — one for aquatic organisms and one for birds — are presented in the following section, followed by a discussion of avian hazard assessment. An Annex to this paper provides more detail on evaluating acute toxicity tests for freshwater fish.

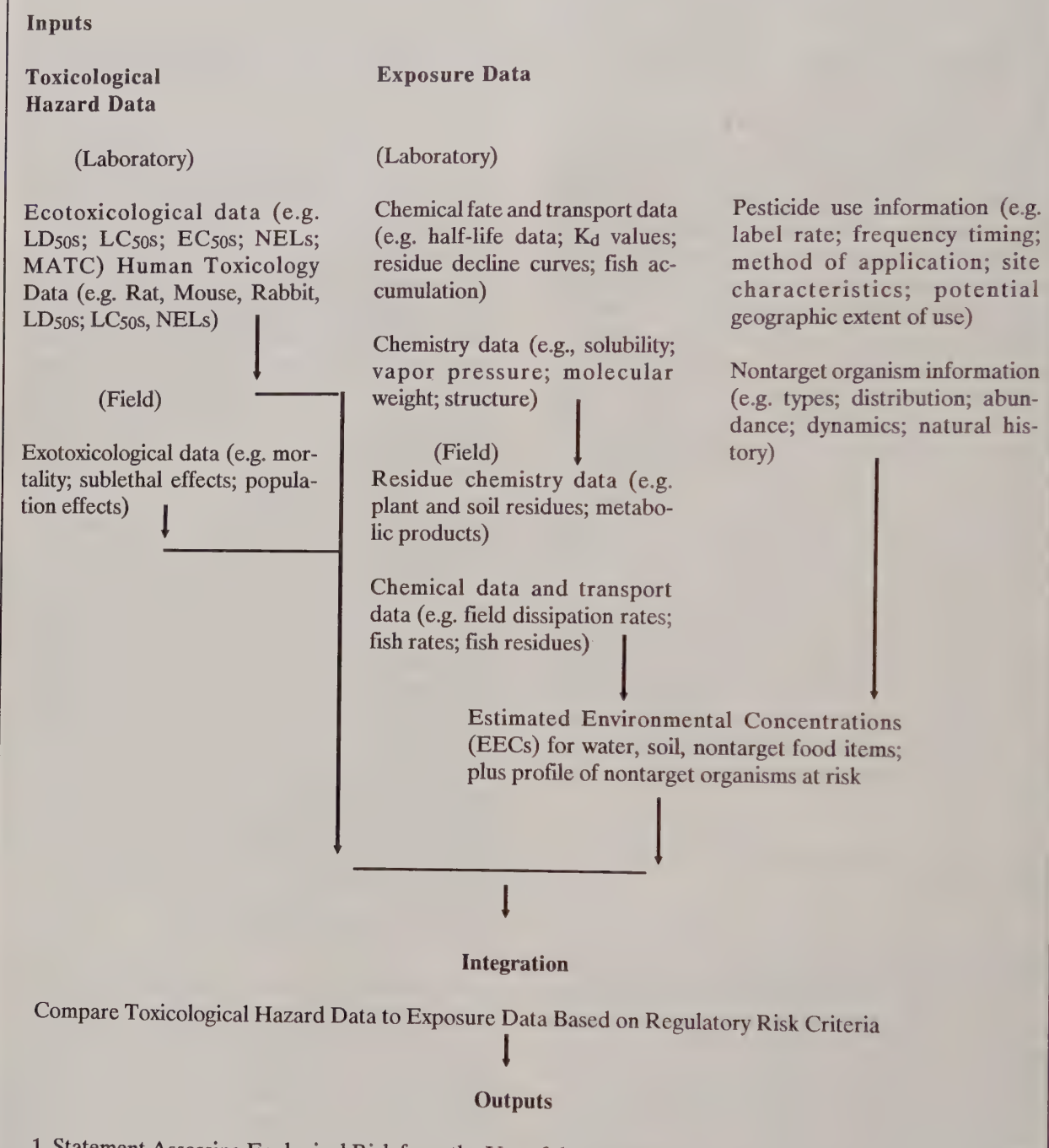
Aquatic Organism Toxicology Testing

All manufacturing products to be reformulated into outdoor end-use products or end products likely to be found in effluent must be tested against three species: a coldwater fish (rainbow trout, *Salmo gairdneri*); a warmwater fish (bluegill sunfish, *Lepomis macrochirus*); and an aquatic invertebrate (water flea, *Daphnia magna*). The two fish are exposed for 96 hours to determine the LC_{50} in ppm and the invertebrate is tested for 48 hours to derive an EC_{50} in ppm. In the event that aquatic organisms experience chronic exposure, tier 2 reproduction studies are required. These tests include a 30- to 60-day fish early life-stage study and a 21-day aquatic invertebrate life-cycle study; both studies yield a no effect level (NEL) and an effect level. Other tier 2 acute studies on estuarine organisms can be required when there exists a potential for pesticide contamination of estuaries — either through direct application as in mosquito control or indirect from drift and runoff. These tests include: 96 hour fish LC_{50}, 96 hour shrimp LC_{50} and either a 48 hour oyster embryo-larvae EC_{50} or a 96 hour oyster shell deposition EC_{50}. Depending upon the results of the tier 1 and tier 2 studies, a fish full life-cycle study (tier 3) and simulated or actual field studies (tier 4) are required.

Avian Toxicology Testing

Unless waivers are granted, most manufacturing-use products and all outdoor end-use products must submit three avian toxicity tests (tier 1) to support their registration. These three studies include one acute oral and two subacute dietary studies. The acute oral study on young adult waterfowl (mallard duck, *Anas platyrhynchos*) or upland game bird (bobwhite quail, *Colinus virginianus*) yields an LD_{50} expressed in

Figure 2. **Flow Chart for Ecological Risk Assessment for Pesticides**


Inputs
Toxicological Hazard Data
(Laboratory)
Ecotoxicological data (e.g. LD_{50}s; LC_{50}s; EC_{50}s; NELs; MATC) Human Toxicology Data (e.g. Rat, Mouse, Rabbit, LD_{50}s; LC_{50}s, NELs)
(Field)
Exotoxicological data (e.g. mortality; sublethal effects; population effects)
Exposure Data
(Laboratory)
Chemical fate and transport data (e.g. half-life data; K_d values; residue decline curves; fish accumulation)
Chemistry data (e.g., solubility; vapor pressure; molecular weight; structure)
(Field)
Residue chemistry data (e.g. plant and soil residues; metabolic products)
Chemical data and transport data (e.g. field dissipation rates; fish rates; fish residues)
Pesticide use information (e.g. label rate; frequency timing; method of application; site characteristics; potential geographic extent of use)
Nontarget organism information (e.g. types; distribution; abundance; dynamics; natural history)
Estimated Environmental Concentrations (EECs) for water, soil, nontarget food items; plus profile of nontarget organisms at risk
Integration
Compare Toxicological Hazard Data to Exposure Data Based on Regulatory Risk Criteria
Outputs
1. Statement Assessing Ecological Risk from the Use of the Pesticide
2. Regulatory Actions

mg/kg. The two subacute dietary studies on 10 to 17-day old waterfowl and upland game bird species provide LC_{50} values in ppm. Each expression of a pesticide's toxicity may have a greater utility over the other depending upon the formulation or use pattern. For example, the LD_{50} is essential for hazard assessments on seed treatments, baits and granular products. In contrast, the LC_{50} values are critical when non-granular products are dispersed directly in or on soil or foliage.

The most frequently requested tier 2 studies are reproduction tests on mallard duck and bobwhite quail. Tier 3 and 4 studies are designed to confirm or rebut the effects observed in any lower-tier study by exposing birds to a pesticide under simulated or actual conditions. The EEB generally prefers to substitute residue monitoring for the use of caged or even large pen studies. A monitoring study involves little or no examination of indigenous wildlife as compared to a full field study. Unlike pen studies on one or two species, biological field studies examine exposure by all routes to numerous species and eliminate the effects of artificial conditions imposed on one or two test species.

Aquatic Exposure Estimates

One simple approach to estimating pesticide residues in ponds adjacent to agricultural land is examined here. Figure 3 is a worksheet to complete when any one of the three major pesticide application techniques are employed. Based on label directions and pesticide water solubility, the amount of pesticide reaching a body of water can be estimated. Assumptions inherent in this scheme include: (i) for a given soil type and slope, percentage of runoff is largely influenced by water solubility – H_20 sol. $\geq$ 100 ppm equals 5 per cent runoff; 100 ppm > H_20 sol. $\geq$ 1 ppm equals 2 per cent runoff; H_20 sol. < 1 ppm equals 1 per cent runoff; and synthetic pyrethroids equal 0.01 per cent runoff; and (ii) instantaneous, even distribution of a pesticide occurs throughout the entire water column.

Terrestrial Exposure Estimates and Hazard Assessments

Potentially exposed species, the magnitude and duration of residues and the pesticide's toxicity are all inputs to EEB's hazard assessment procedure. Depending upon the formulation of the end-use product – a nongranular or granular/bait – different methods for further exposure determination and hazard assessment are employed.

Granular Formulation. The amount of active ingredient on the soil surface is calculated as follows: if the product is a 10 per cent a.i. granular formulation, broadcast at a rate of 100 lb product/acre, then the amount of a.i. is 10 lb per acre or 104 mg a.i./ft^2. Additional refinements to this assessment are made as a function of: (i) application technique – broadcast or banded; the latter results in more pesticide per treated square foot than the former; (ii) incorporation into the soil or no incorporation; and (iii) the size and weight of the granules. Should a sufficient amount of toxicant be readily available (e.g. within a square foot on the soil surface) to provide birds with their lethal dose (mg/animal), then whether the birds will actually be able or inclined to ingest a lethal number of granules must be considered. Assuming birds would consume the granules, the higher the hazard ratio (see below) the greater the hazard.

$$\text{hazard ratio} = \frac{\text{amount of toxicant/ft}^2}{LD_{50}}$$

Nongranular Formulation. Unless measured residues on bird food items are available, EEB typically refers to a nomograph to estimate pesticide exposure (Figure 4).[1] The authors examined the residue levels of 28 different pesticides in or on 60 crops (totaling more than 250 different pesticide-crop combinations) at various time intervals after application. From these levels the authors developed maximum expected residues

1/ This nomograph was based upon the following two papers: F.D. Hoerger and E.E. Kenaga, "Pesticide residues on plants. Correlation or representative data as a basis for estimation of their magnitude in the environment", pp. 9-28 in Environmental Quality I. Academic Press, New York, 1972; and E.E. Kenaga, "Factors to be considered in the evaluation of the toxicity of pesticides to birds in their environment", pp. 166-181 in Environmental Quality and Safety, Global aspect of chemistry, toxicology and technology as applied to the environment, II, Academic Press, New York, 1973.

Figure 3. Estimated Environmental Concentration (EEC) Calculation Sheet

I. For Unincorporated ground application

A. Runoff

_____ lb(s) x 0.0 (__ % runoff) x 10 (acre) (from 10 acre drainage basin) = _____ lb(s) (total runoff)

EEC of 1 lb a.i. direct application to 1 acre pond 6-foot deep = 61 ppb
Therefore, EEC = 61 ppb x _____(lb) = _____ ppb

II. For Incorporated ground application

A. Runoff

_____ lb(s) – ____ (cm) (depth of incorporation) x 0.0 (___ % runoff) x 10 (acre) (10 acre drainage basin) = _____ lb(s) (total runoff)

Therefore, EEC = 61 ppb x _____ (lbs) = ____ ppb

III. For aerial application (or mist blower)

A. Runoff

_____ lb(s) x 0.6 (application efficiency) x 0.0 (__ % runoff) x 10 (acre) (10 acre drainage basin) = _____ lb(s) (total runoff)

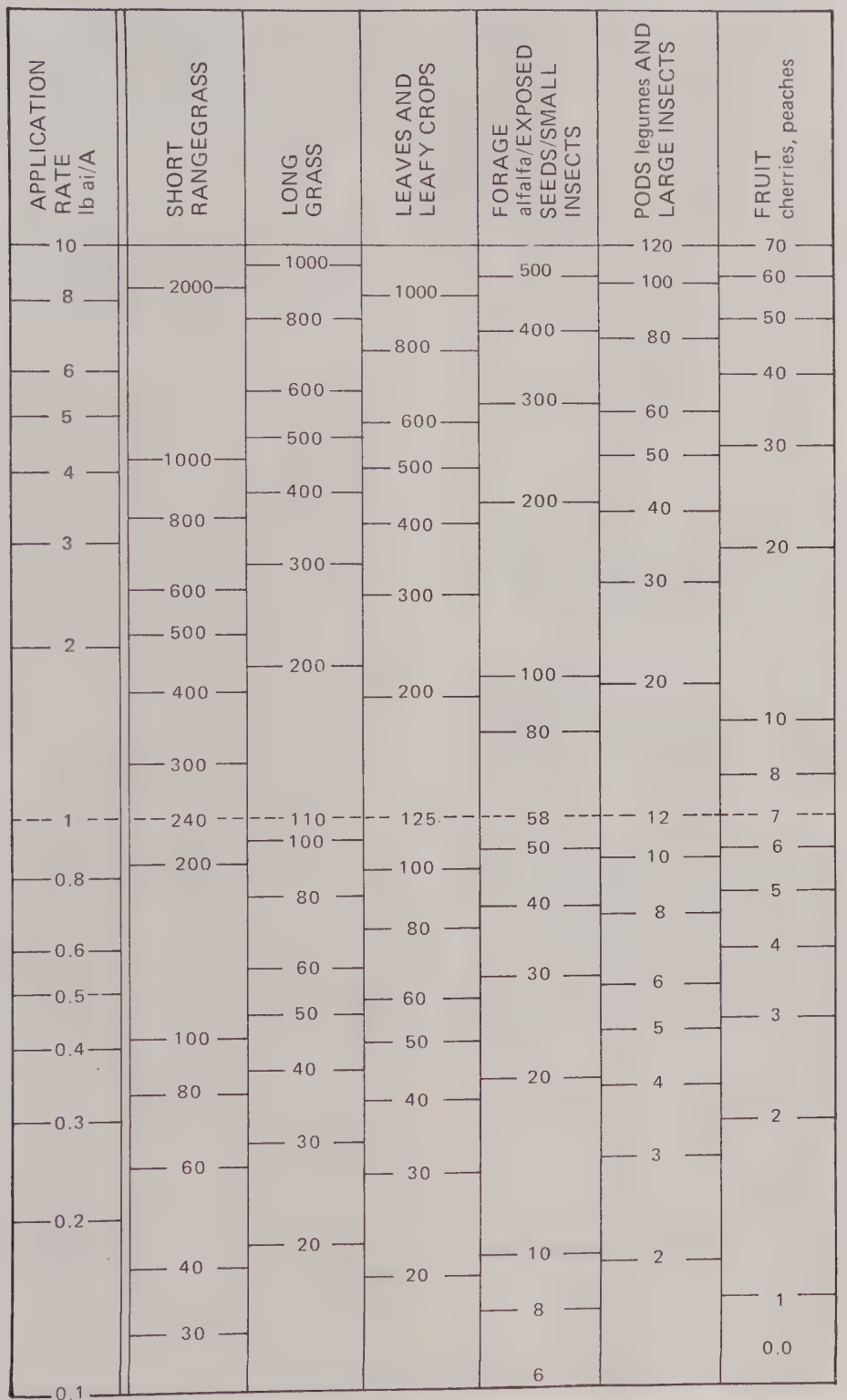
B. Drift

_____ lb(s) x 0.05 (5% drift) = _____ lb(s) (total drift)

Total loading = _____ lb(s) (total runoff) + _____ lb(s) (total drift) = _____ lb(s)

Therefore, EEC = 61 ppb x ____ lb(s) = ____ ppb

Figure 4. **Initial Maximum Expected Pesticide Residues (ppm) Following Topical Application of a Liquid Spray**



immediately after treatment for various application rates to numerous food wildlife items.

Potential hazard from nongranular products is derived by comparing actual or estimated residues with a test species LC_{50} to derive a hazard ratio. For example, by referring to the nomograph, an application rate of 1.0 lb a.i./acre results in estimated residues on seeds of 58 ppm and short grass of 240 ppm. Comparing these residues to a hypothetical pesticide's LC_{50} values of 100 ppm for the bobwhite quail (a seed eater) and 50 ppm for the mallard duck (representing grazers) two hazard ratios (0.58 and 4.8 respectively) are derived. Therefore, although the acute poisoning hazard to seed eaters is considered low (hazard ratio is less than 1) the hazard to grazers is believed to be high (hazard ratio is greater than 1). This approach is based on the assumption that a bird consumes only contaminated feed consisting entirely of a single substrate grouping.

Regulatory Components of Hazard Assessment

From a regulatory standpoint, EEB hazard assessment provides information to address three subjects: (i) precautionary labeling, (ii) additional studies, and (iii) use classification and hazard status.

Precautionary Labeling. Environmental safety precautions consist of three parts: (i) a statement of toxicity; (ii) statements indicating how hazard may occur; and (iii) statements giving instructions to avoid or minimize hazard.

The toxicity statement, "This pesticide is toxic to birds" is prescribed when the LC_{50} is less than 500 ppm or the LD_{50} is less than 100 mg/kg. Should a pesticide have a history of bird kills associated with routine cultural practices for registered uses, the toxicity statement is modified to read, "This pesticide is extremely toxic to birds". Statements such as "birds feeding on treated areas may be killed" are used if field studies or use history have demonstrated mortality. Regardless of a pesticide's toxicity or use history, additional instructions to further reduce hazard are required. Such directions include, "Do not contaminate water when disposing of equipment washwaters" and "collect or incorporate spills" (especially for granular or seed treatment products).

Additional Studies. Whenever the available information is sufficient to indicate little or no hazard to birds, and the acute/subacute studies fulfill guideline requirements to permit labeling, further testing is not requested. However, should the studies be inadequate to prescribe labeling, or should the preliminary assessments lack pertinent data or suggest severe adverse effects, additional testing is required.

Use Classification/Hazard Status. When a product's registration would not result in severe adverse effects there remains the decision as to who may apply the product. The product could be restricted and thereby require an applicator to be certified, or remain unrestricted for use by the general public. In those instances where the severity of the hazard exceeds an established criteria, the use may be prohibited.

Conclusions

The EEB's initial appraisal of a pesticide's hazard to nontarget species is contingent upon availability of basic ecotoxicology data, use pattern information and the pesticide's fate during and after application. Frequently, extrapolation from surrogate data (residue and toxicity) forms the basis for a preliminary hazard assessment. Pesticides exceeding the criteria for severe adverse effects are subject to closer scrutiny before a final regulatory decision is made. These pesticides usually require higher-tier testing such as residue monitoring or field studies.

Annex: Standard Evaluation Procedure for Acute Toxicity Test for Freshwater Fish

This Standard Evaluation Procedure (SEP) is one of a set of guidance documents which explain the consideration given to evaluate environmental health effects data.

Introduction

When is Testing Required? Acute toxicity testing on freshwater fish is required to support registration of manufacturing-use pesticide products and end-use pesticide products intended for outdoor application.

Purpose. Acute toxicity studies on freshwater fish determine the lethal concentration (LC_{50}) of a chemical which will kill fifty per cent of the test population in 48 to 96 hours. These acute tests have attained broad acceptance among environmental toxicologists as relatively rapid, uncomplicated, inexpensive, and statistically reliable methods for assessing immediate, short-term, adverse effects of chemicals on fish.

The EEB regularly requires that results of two freshwater fish acute toxicity tests be submitted to support the registration of a pesticide. One study should be performed on a coldwater fish species and one study on a warmwater fish species. The data from these tests are used:

- to establish acute toxicity levels of the active ingredient to nontarget freshwater fish;
- to assess the potential impact to fish by comparing toxicity information with measured or estimated pesticide residues in the freshwater environment;
- to provide support for precautionary label statements that will minimize adverse effects to fish when the pesticide is used according to directions; and
- to indicate the need for further laboratory testing and/or field studies.

Test Material

Technical Grade. Tests must be conducted with the technical grade of the active ingredient. If more than one active ingredient constitutes a technical product, the technical grade of each active ingredient must be tested separately.

End-Use Product. Besides technical product testing, the applicant may be required to test the end-use product as well if:

- the end-use product will be introduced directly into an aquatic environment when used as directed;
- the freshwater fish LC_{50} of the technical grade of the active ingredient is equal to or less than the expected environmental concentration in the freshwater environment when the end-use product is used as directed;
- an ingredient of the formulated end-use product is expected to enhance the toxicity of the end-use product beyond that expected from the active ingredient(s) alone; or
- the technical product is insoluble in water but the formulated product is soluble in water. In this situation, the test design should include a control where organisms are exposed to just the inert ingredients and carriers.

Materials and Methods: Testing Standards/Data Acceptability

Recommended Protocols. Because the acute test is an established technique for assessing toxicity of a chemical to freshwater fish species, much of the methodology for performing these studies, as well as the procedures for statistical analyses of results, have been carefully outlined and documented in the published

literature. Notably, the information to be discussed in this US EPA Standard Evaluation Procedure (SEP) is presented in greater detail in the following references:

Committee on Methods for Toxicity Tests with Aquatic Organisms. 1975. *Methods for Acute Toxicity Tests with Fish, Macroinvertebrates and Amphibians.* US EPA, Ecol. Res. Series, EPA 660/375-009. 61 pp.

American Society for Testing Materials (ASTM). 1980. *Standard Practice for Conducting Acute Toxicity Tests with Fishes, Macroinvertebrates and Amphibians.* E 729-80. Published by ASTM Committee on Standards, 1916 Race Street, Philadelphia PA, 19103.

Peltier, William. 1978. *Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organisms.* US EPA, Ecol. Res. Series, EPA 600/4-78-012. 52 pp.

US EPA. *Pesticide Assessment Guidelines Subdivision E. Hazard Evaluation: Wildlife and Aquatic Organisms.* EPA-540/9-82-024.

These referenced protocols are presented as flexible guidance tools to help researchers design scientific protocol and to help the reviewer validate studies. It is important to recognize that freshwater fish tests are validated as to whether they provide scientifically sound information on the acute toxicity of the test material to fish and whether the results of the study will fulfill guideline requirements. This is more important than whether a study completely conforms to referenced protocols. It is sometimes necessary to alter the procedures presented in published protocols to meet the characteristics of the chemical or test organisms used.

The static test is the standard technique for obtaining LC_{50} values for fish, however flow-through testing may be needed when toxicants are highly volatile or otherwise unstable in the aqueous environment, or when a chemical has a high biochemical oxygen demand. The information as it is presented below will focus on static testing protocols. Specific references to acceptable flow-through methods are indicated when necessary.

Test Organisms

Acceptable Species. The preferred test species for the coldwater fish toxicity test is the rainbow trout (*Salmo gairdneri*). The bluegill sunfish (*Lepomis macrochirus*) is the recommended species for warmwater fish toxicity testing. Other acceptable species include:

Coldwater species:
Brook trout (*Salvelinus fontinalis*);
Coho salmon (*Oncorhynchus kisutch*); and
Warmwater species:
Channel catfish (*Ictalurus punctatus*); and
Fathead minnow (*Pimephales promelus*).

Size/Age/Physical Condition. Individual fish should weigh between 0.5 and 5 grams and should be of the same year class. The standard length of the longest fish should not be more than twice the length of the shortest fish. Very young (not actively feeding), sexually mature, spawning, or recently spent fish should not be used.

Source/Acclimation. All organisms must be from the same source. This may include laboratory or commercial stocks. Animals captured in the wild are acceptable provided they meet the requirements pertaining to physical condition and age/size criteria mentioned above. Organisms captured via chemical treatment must not be used. When test animals are brought into the laboratory, they should be quarantined for at least seven days. It is recommended that fish be acclimated to study conditions for at least two weeks prior to testing.

Test organisms must be observed prior to testing for signs of disease, stress, physical damage, and mortality. Injured, dead and abnormal individuals must be discarded. If the organisms show signs of disease or stress, remedial action must be taken during the acclimation period and not during the test phase.

Organisms that have been treated for disease are acceptable for testing provided they do not exhibit signs of disease during the 48-hour pretest. Organisms must not be used if they appear to be diseased or stressed of if more than 3 per cent die during the 48 hours immediately prior to testing.

If possible, feeding of the fish should be limited to the time just prior to testing. This reduces the amount

of organic material generated in the test vessels. Organic matter may alter the test results by adsorbing the chemical or increasing the oxygen demand of the test solution.

Test System

Source of Dilution Water. Whenever possible, soft, reconstituted water should be used for freshwater studies. Reconstituted water should be aged one or two weeks and intensely aerated prior to use. Detailed descriptions of acceptable procedures for preparing diluent are found in the protocols by the American Society for Testing Materials (1980) or the Committee on Methods for Toxicity Tests with Aquatic Organisms (1975).

Use of a natural dilution water with a hardness of 40 to 48 mg/L as $CaCO_3$ can be used in lieu of reconstituted water. If possible, natural dilution water should be obtained from an uncontaminated well, spring, or surface water source. Dechlorinated water should not be used because removal of chlorine is rarely complete and residual chlorine can be quite toxic to aquatic organisms.

The dilution water must be able to support the test animals without observable signs of stress such as discoloration or unusual behavior.

Temperature. The recommended temperature for testing coldwater fish species is 12°C. Warmwater fish tests should be performed at 17°C or 22°C.

Testing facilities should have a constant temperature area or a recirculating water bath for the test vessels.

Test Vessels. Test containers should be constructed from welded stainless steel or glass. Vessels with dimensions of about 300 x 600 x 300 mm depth are acceptable for both static and flow-through tests. Static tests are frequently performed in 18.9 L (5 gallon) wide-mouth glass jars containing 15 L solution.

If test vessels are constructed from materials other than glass or stainless steels, the solution must be analyzed to determine exact toxicant concentrations. Past studies have shown that some test vessel materials (e.g. polyethylene) can adsorb residues of the pesticide being tested.

The metering system chosen for flow-through studies must reproducibly supply appropriate toxicant concentrations at a consistent flow rate. Metering systems should be calibrated before and after each study and checked twice daily during the test period. Flow rates should be five to ten volume additions per 24 hours. Systems should be constructed so that the organisms are not stressed by turbulence.

Photoperiod. A 16-hour light and an 8-hour dark photoperiod with a 15- to 30-minute transition period between light and dark is recommended.

Loading. The size of the test container should be such that the loading factor (test organism mass per volume of test solution) is no greater than 0.8 g/L in static tests performed at or below 17°C. At higher temperatures, a biological loading of 0.5 g/L of test solution is acceptable. For flow-through tests, the loading should be no greater than 1 g/L of solution passing through the chamber in 24 hours, and must not exceed 10 g/L of the test solution at any time at or below 17°C or 5 g/L at higher temperatures.

Solvents. Whenever possible, the toxicant should be introduced into the test solution without the use of solvents other than water. If alternative solvents are necessary, they should be used sparingly, not to exceed 0.5 ml/L in any static test solution and 0.1 ml/L under flow-through conditions. The following solvents are preferred: dimethyl formamide; triethylene glycol; methanol; acetone; and ethanol.

Test Design

Test Levels. Initially, range-finding tests may be necessary to define concentrations of the toxicant needed for definitive studies. If results from a range-finding study indicate a low toxicity for the chemical, a definitive test need not be performed. However, it must be determined that the chemical will have an LC_{50} greater than 100 mg/L, by exposing at least 30 individuals to a concentration of 100 mg/L or greater.

Definitive acute toxicity tests normally are designed to include one or more control groups and a geometric series of at least five toxicant concentrations to be tested. Each designated treatment group should be exposed to a concentration of toxicant that is at least 60 per cent of the next highest concentration.

Number of Test Animals. In definitive tests, at least ten test organisms should be exposed to each treatment level. Treatment groups can be divided into two or more containers. All organisms must be randomly assigned to test vessels.

Controls. Each test requires a concurrent control using the same dilution water and the same number of organisms per test level. If a solvent other than water is used, a solvent control should be established. The highest concentration of the solvent that was added to any of the study chambers should be tested as the control.

A study is not acceptable if more than 10 per cent of the control organisms die during a static test or 5 per cent during a flow-through study.

Beginning the Test. Static acute tests are initiated either by adding the test material to the test chambers after the fish are added or by adding the fish to the test chambers within 30 minutes after the test material is added to the dilution water.

Measuring Temperature/DO/pH. Temperature should be measured continuously (hourly) in at least one test vessel during the entire study period. If temperature is controlled by a water bath, measurements can be recorded every six hours. Temperature should not vary more than one degree Centigrade (C) during the entire study period.

The dissolved oxygen (DO) concentration must be measured at the beginning of the test and every 48 hours thereafter to the end of the test. Measurements should be taken from the control and the high, medium, and low concentrations as long as animals are present at those levels. The DO level during the first 48 hours should be between 60 per cent and 100 per cent of saturation, and between 40 per cent and 100 per cent saturation after 48 hours. In the flow-through test, the DO concentrations in each chamber should be between 60 per cent and 100 per cent saturation at all times during the study.

The pH should be measured at the beginning and end of the test in the control and the high, medium, and low toxicant concentrations.

Chemical Analysis. It is preferred that test solutions be chemically analyzed to determine exact concentrations of pesticides. It is particularly important that residues are measured if:

- the test solutions were aerated (aeration may cause volatilization of the pesticide);
- the test material was volatile, insoluble, or precipitated out of solution;
- the test containers were not made of stainless steel or glass;
- the test chemical is known to adsorb to the test container's structural material; or
- a flow-through system is used (measurement verifies accuracy of metering system).

Reporting Requirements

The test report submitted to US EPA must fully describe the materials and methodology used to perform the study. The reviewer must be able to establish from the report that the study was performed under conditions that render the results acceptable for use in a risk assessment and/or for fulfilling the guideline requirements. The following information is particularly important for a complete evaluation.

Test Material. If the study is to be performed with the technical grade product, the test material should be clearly identified as to source, batch, and exact purity. Simply identifying the material as technical may not be acceptable because the percentage of active ingredient of some newer products may increase with time as the manufacturing process is improved to produce greater yield.

For studies involving the end-use product, the exact percentage of the active ingredient and the type of formulation (e.g. granular, wettable powder) of the test material should be described. It should be clearly stated in the test report whether results are expressed in terms of active ingredient or as total formulated product.

Dilution Water/Test Vessels. Test reports submitted to US EPA should include a complete description of dilution waters used in the toxicity studies. Descriptions should include identification of the source, the chemical characteristics of the water, and information on any pretreatments.

Test vessels should be described as to construction material and size, as well as depth and volume of solution.

Test Organisms. Test reports should provide complete descriptions of source, holding, and acclimation conditions including information on feeding schedules and disease treatment procedures.

The age, average weight, and length of test fish should be reported. Species should be identified by scientific name.

Range-Finding Tests. Test reports should provide information describing range-finding study procedures and results. The information should include sample sizes, concentrations tested, and mortality data.

Definitive Tests. Procedures used to prepare toxicant stock solutions and test aliquots should be described thoroughly.

The criteria for determining effects must be defined. The raw data or percentage of deaths at each level as well as the number of fish tested per level must be reported for each 24-hour period of the study. Toxic symptoms (physical and behavioral) should be described throughout the test period.

Calculated LC_{50}. The statistically calculated LC_{50} with 95 per cent confidence limits and method of calculation must be presented. The slope of the dose-response line should be calculated and reported.

In lieu of a calculated LC_{50}, the study may show that the LC_{50} is greater than 100 ppm.

Temperature/DO/pH. Dissolved oxygen and pH measurements should be reported along with the range and average temperature.

Chemical Analyses. If chemical analyses are conducted, the test report should provide information on the methods (or references to established methods) used and results of those analyses. Residues found at the beginning and end of the study should be reported.

Testing Protocols. The test report should include references to any protocols followed during the test.

Reviewer's Evaluation

Review of Test Conditions. The reviewer should note any important information missing from the submitted report. Also noted are conditions of the study that are inconsistent with recommended methodologies as discussed in this SEP or in designated references.

Verification of Statistical Analyses. An integral part of the data evaluation process is the verification of statistical analyses. The reviewer should ensure that the LC_{50} has been properly derived by recalculating data through currently available statistical programs.

An acceptable acute toxicity test should provide additional important information other than the LC_{50} (EC_{50}). Results from a valid study should provide a zero mortality level and a slope of the dose-mortality response line. These data can give further insight into the toxicological characteristics of the chemical such as whether the response is gradual over a wide concentration range or relatively rapid over a narrow range.

If the recalculated results differ substantially from the submitted results, the reviewer should note this and attempt to explain the discrepancies.

A test can be considered unacceptable if more than 10 per cent of the control organisms die during the study period. An inadequate number of test organisms per test level can also produce unreliable results.

Conclusions.

Categorization of Results. The significance of inconsistencies in the test procedure must be determined by the reviewer so that the results of the study can be categorized as to their usefulness in a risk assessment. Categories are described as core, supplemental or invalid.

- **Core.** All essential information was reported and the study was performed according to recommended protocols. Minor inconsistencies with standard methodologies may be apparent; however, the deviations do not detract from the study's soundness or intent. Studies within this category fulfill the basic requirements of Part 158 of the regulations and are acceptable for use in a risk assessment.

Table 5. Additional Standard Evaluation Procedures

Ecological Risk Assessment	EPA-540/9-85-001
Acute Toxicity test for Freshwater Invertebrates	EPA-540/9-85-005
Avian Single-Dose Oral LD_{50}	EPA-540/9-85-007
Avian Dietary LC_{50} test	EPA-540/9-85-008
Acute toxicity test for Estuarine and Marine Organisms (Estuarine Fish 96-Hour Acute toxicity test)	EPA-540/9-85-009
Acute toxicity test for Estuarine and Marine Organisms (Shrimp 96-hour acute toxicity test)	EPA-540/9-85-010
Acute toxicity test for Estuarine and Marine Organisms (Mollusc 96-hour Flow-through Shell Deposition Study)	EPA-540/9-85-011
Fish Life-Cycle Toxicity tests	EPA-540/9-86-137
Fish Early Life-Stage	EPA-540/9-86-138
Avian Reproduction Test	EPA-540/9-86-139
Daphnia Magna Life-Cycle (21-day Renewal) Chronic toxicity test	EPA-540/9-86-141

- **Supplemental.** Studies in this category are scientifically sound; however, they were performed under conditions that deviated substantially from recommended guideline protocols. Results do not meet regulatory requirements; however, the information may be useful in a risk assessment. Some of the conditions that may place a study in a supplemental category include:
  - unacceptable test species;
  - inappropriate test material;
  - dosage levels tested were less than 100 ppm but not high enough to produce an effect on the organisms or a precise LC_{50} (EC_{50}); or
  - deviations from recommended test solution characteristics exist (variations in DO, temperature, hardness, and pH can affect toxicological response).

- **Invalid.** These studies provide no useful information. They are not scientifically sound, or they were performed under conditions that deviated so significantly from recommended protocols that the results will not be useful in a risk assessment.
  - Examples of studies placed in this category commonly include those where the test system was aerated, test vessels were constructed from materials other than glass, or there were problems of solubility or volatility of the test material. Unless acceptable chemical analyses of actual toxicant concentrations were performed in studies such as these, the reviewer cannot be sure that organisms were actually exposed to nominally designated residues. Also, a study where the test material was not properly identified can be invalidated.

Rationale. To support a supplemental or invalid category, the reviewer must list and explain all test conditions that deviated from standard protocols.

Repairability. If any or all of the deviations can be re-examined and found acceptable (i.e. the study category can be upgraded), the reviewer also discusses this. Usually to upgrade a study, additional information must be acquired.

Descriptive Classification. Valid aquatic LC_{50} (EC_{50}) toxicity values can be categorically compared to LC_{50} (EC_{50}) values determined for other chemicals and/or species by the following descriptive classification:

LC_{50} (EC_{50}) (ppm)	Category Description
< 0.1	very highly toxic
0.1 - 1	highly toxic
$> 1 \leq 10$	moderately toxic
$> 10 \leq 100$	slightly toxic
> 100	practically non-toxic

These descriptive categories are for inter-chemical comparisons only and do not reflect actual environmental hazard to freshwater organisms.

Checklist for Evaluating an Acute Toxicity Test for Freshwater Fish

General Information

1. *____ Date of test initiation and termination reported

Materials/Methods

2. Identification of test substance
   - *____ Chemical name
   - ____ Composition
   - *____ Per cent active ingredient (technical grade)
   - ____ Source, lot number, or code
   - ____ Identity and composition of impurities

3. Preparation of test solution (control/treatment) described
   - *____ Any vehicle used to dissolve test material
   - *____ If used, amount of vehicle added to control
   - *____ Method used to get test material into solution was described
   - *____ Water source
   - *____ Water solubility of test material reported in ppm
   - ____ Total amount of test material used
   - ____ Temperature of water

4. Test fish
   - *____ One of the following organisms was tested: rainbow trout, bluegill, brook trout, coho salmon, channel catfish, fathead minnow
   - ____ History of test organisms described (strain, diseases, and treatment)
   - ____ Health described including sickness, injuries, abnormalities, name of medication (if used), and pretest diet
   - *____ Weight in grams (0.5 to 5) and length in mm reported

5. *____ Source/acclimation described
   Complete name and address of test fish supplier, source of food and dilution water, size of test container in milliliters (ml), temperature, pH, dissolved oxygen, name of equipment used to measure water quality, feeding schedule, holding and acclimation period, test organisms from the same source, number of days held

6. Composition and size of test vessels described
   - *____ Material type
   - *____ Volume in liters (L)
   - *____ Depth of test solution in cm or volume of dilution water (L)

* Essential information to confirm scientific soundness of study.

7. Test system described
   - *____ Source of dilution water
   - *____ If flow-through, system and flow rate/day described
   - *____ Procedures used to prepare toxicant stock solution
   - *____ Criteria used to determine effect

8. Test design followed
   - *____ Method used in assigning test organisms to test and control groups and the number of replicates used
   - *____ Number of fish per dose level and control group (minimum 10)
   - ____ Name of protocol followed during the tests
   - *____ Loading (weight per unit volume of water with no more than 0.8 g/L for static and 1.0 g/L for flow-through)
   - *____ 5 treatments and 1 control used
   - *____ Length of exposure period (96-hours minimum)
   - *____ Type of control (positive, negative, or solvent control)
   - *____ Temperature ($12^{\circ}C \pm 2^{\circ}$ for coldwater fish and $17^{\circ}C \pm 2^{\circ}$ or $22^{\circ}C \pm 2^{\circ}$ for warmwater fish)
   - *____ pH
   - ____ Lighting (time in hours and intensity - footcandles)
   - *____ Dissolved oxygen
   - ____ Water hardness expressed in mg/L as $CaCO_3$
   - ____ Alkalinity expressed in mg/L as $CaCO_3$
   - ____ Conductivity (umhos/cm)
   - ____ Range finding test results, concentrations, and mortality, if used
   - *____ Water not aerated during exposure to pesticides unless concentrations are measured
   - ____ Water: physical characteristic at the end of test - depth and volume

Discussion and Results

9. *____ LC_{50} value reported in ppm with 95 per cent confidence limits

10. *____ Any precipitation and solubility problems

11. *____ Statistical method referenced

12. ____ Discussion of concentration(s) producing intoxication provided
    - *____ Water: physical characteristic at end of test - temperature, pH, and dissolved oxygen
    - *____ Concentration analysis (if flow through) or other conditions require
    - *____ Fish physiology, locomotion, behavior and pathology described
    - *____ Mortalities during the test described

13. *____ The no-observed-effect level if determined

14. *____ Raw mortality data provided

15. ____ Graphs, printouts and other calculations should be attached to the report

Pesticide Labeling and Pictograms

By **Brian B. Watts**
Consultant, Pesticide Regulatory Affairs

The use of pictograms — symbols that convey a message without the use of words — was first suggested by the FAO Group of Experts at a meeting held in December 1984, following consideration of a number of proposals studied by the Group. Following this meeting, GIFAP also established its own Working Group in 1985 to investigate the use of pictograms. An extensive worldwide survey was conducted following the development of a number of pictograms by the GIFAP Working Group. The set of pictograms presented in the FAO Guidelines on Pictograms for Pesticide Labels were those most readily understood by most of the users surveyed. The Guidelines describe how the pictograms should be used and present examples of such use (see Box 3).

Development of Pictograms

The FAO Guidelines on Good Labelling Practice for Pesticides were considered by the Fifth Meeting of the FAO Panel of Experts on Pesticide Specifications, Registration Requirements and Application Standards in December 1984. At that meeting, draft pictograms were discussed, but were not published as the Group felt that publication would have been premature. The FAO Group recommended that priority be given to the development of a system of pictograms capable of being understood by people of diverse cultures and of low levels of literacy.

GIFAP's Working Group, consisting of industry experts in pesticide safety, labeling and communications, and representatives of the UK Overseas Development Natural Resources Institute (ODNRI), the Overseas Development Administration (ODA), and FAO, first considered previous work which had been carried out on pesticide labeling and safe-use pictograms.

The principal constraint encountered by the Working Group was the limited space on the label, which meant that the number of messages had to be severely restricted. This required a careful ranking of the importance of the various messages in order of importance. It was also decided that the best place to locate the pictograms on the label was in the color band recommended in the FAO Guidelines on Good Labelling Practices for Pesticides, since research indicated no loss of impact of the hazard warning band when pictograms were inserted there. The Group also faced the problem of linking advice given by the pictograms to the activity being carried out. It may, for example, be necessary to wear eye protection when mixing the concentrate but not when applying the ready-to-use spray. Since it was considered desirable not to make the pictograms too complex, it was decided to link "advice" pictograms to "activity" pictograms which indicated either the handling of the concentrate or spraying of the diluted product.

Three designs were developed by graphic designers with the requirement that the designs developed were to be understandable to people of diverse cultures and low levels of literacy. To decide which pictogram system and which individual pictograms were most readily understood, it was agreed that they must be tested on individual users. A market research company was engaged to do this work, which was done in accordance with the Code of Conduct developed by the Market Research Society of Great Britain and the European Code of Social and Marketing Research Practice.

Some 3,000 questionnaires were distributed worldwide by GIFAP and FAO together with instructions to interviewers on how to conduct the interviews. Almost 1,000 completed returns were received from 42 countries. The regional distribution is shown in Table 6.

The response was considered excellent in view of the length and nature of the questionnaire. It was by far the largest and most geographically and culturally

Table 6. Questionnaire Responses

Areas	No. of Questionnaires	%
Europe	105	11
Middle East	69	7
Africa	153	16
Indian subcontinent	127	14
Far East	237	25
Australasia	41	4
Latin America	214	23
Total	946	100

Table 7. Rate of Understanding

	% responding "B" is easiest to understand
Middle East	74
Africa	73
Far East	73
Australasia	73
Latin America	71
India	55
Europe	48

comprehensive survey of pesticide pictograms ever conducted.

Results of the Survey

Over 60 per cent of those sampled thought that pictograms were very useful with a further 26 per cent saying that they were quite useful. In other words, nearly 90 per cent of respondents found pictograms "useful".

On the whole, recognition of individual pictograms was good. For example, for pictograms symbolizing the recommendation to wear boots; wear gloves; wear a mask; wear eye protection; or wash; a spontaneous level of understanding of between 75 and 85 per cent was achieved. Less successful were the pictograms relating to water sources, livestock and safe storage. As a yardstick, 80 per cent of the sample understood the meaning of the skull and cross bones pictogram.

Less than 35 per cent of the sample were able to distinguish spontaneously that there were two separate activities: handling the concentrate, and spraying. Hence, a publicity program to cover this aspect of the pictograms specifically will be needed.

Relatively few respondents (about 15) commented on the shape and color of the pictograms, from which it would appear that these are not important factors influencing the degree of understanding.

Set "B" (the set finally chosen with modifications, and published in the FAO Guidelines) was by far the most readily understood of the three sets tested. The percentage response from the various areas is shown in Table 7.

There were no differences worthy of note regarding the above results when analyzed by such factors as age or educational level of respondents.

Action Taken as a Result of the Survey

After examining the results of the sampling, the Seventh Session of the Group of Experts agreed that Guidelines on the Use of Pictograms should be prepared as soon as possible to facilitate their early use on pesticide labels, and agreed that the appropriate place to use the pictograms would be in the color band stipulated in the FAO Guidelines on Good Labelling Practice for Pesticides. As the survey had not indicated any advantage in the use of color, it was also agreed that the pictograms should be printed in black and white.

FAO Guidelines. Both FAO and GIFAP have published similar Guidelines on Pictograms. FAO's publication is intended as an addendum to its Guidelines on Labelling. The layouts suggested for the pictograms are in accordance with those Guidelines, with the exception of a modification to the placement of the warning symbols. These should now be at the top of the color band rather than at the top of the label as was originally recommended. The pictograms, which should be printed in black and white, are most conveniently located at the bottom of the label. Their size should be appropriate for the label on which they are to appear. For labels on bottles of 1 to 5 liter capacity, the preferred size is 15 mm x 15 mm, but pictograms should never be smaller than 7 mm x 7 mm.

Box 3. How to Use Pictograms

The activity pictogram for **handling the product** in its pack or container should appear to the **left** of center of the label, with associated advice pictograms grouped to the **left** of it. The activity and advice pictograms should be enclosed in a clearly defined "box" to show that they are linked.

The activity pictogram for the appropriate **method of application** should appear to the **right** of the center of the label with associated advice pictograms grouped to the **right** of it, enclosed in a "box" to show that they are linked.

The pictogram showing that people **must wash after using pesticides** should also appear on **all** labels and should be printed to the **right** of the group of pictograms associated with the application of the product.

The **environmental warning** pictograms, when they are needed, should appear to the **right** of the "wash after use" pictograms.

CENTER

The pictogram showing that **pesticides should be locked away out of reach of children** should be on **all** labels and should appear to the **left** of the group of pictograms associated with handling of the concentrate.

The pictograms used on any individual pesticide label **must** relate to specific safety advice associated with that product: the lower the hazards associated with the product, the fewer pictograms needed.

The pictograms should be featured on labels in the best way to suit the design of the particular label. All labels should conform to national requirements which must take precedence over any proposals made in the FAO Guidelines.

It is recommended that governments and industry act to incorporate these pictograms on pesticide labels, and to educate pesticide users about them. In doing so, three points must be kept in mind:

- pictograms are intended to supplement the existing text on labels, not to replace it;
- while it may sometimes be appropriate to use pictograms other than the ones in the FAO Guidelines, care must be taken not to use too many so as not to confuse the user; and
- the use of pictograms must not conflict with any national regulations.

A number of countries are now using pictograms. At the recent Noumea Workshop held under Project GCP/INT/457/JPN a recommendation was passed encouraging companies supplying pesticides to Pacific Island countries to use pictograms on the products sent to that area.

Module C: Post-Registration Activities

Application of FAO Guidelines in Post-Registration Activities

By **A. Balasubramaniam**
Secretary, Pesticides Board, Department of Agriculture, Malaysia

Registration is the process whereby the responsible national government authority approves the sale and use of a pesticide following the evaluation of comprehensive scientific data demonstrating that the product is effective for the purposes intended and not unduly hazardous to human or animal health or the environment. A number of activities must, therefore, occur before a pesticide product is introduced into the market. These were discussed in Modules A and B.

Post-registration activities, in turn, assure that the registered product is properly handled, distributed, and used in accordance with all applicable rules, regulations and conditions of registration. Recognizing the importance of post-registration surveillance as a needed support to registration, FAO developed its Guidelines on Post-registration Surveillance and Other Activities to assist governments in addressing this need and to ensure that the registration objectives are achieved.

Monitoring Activities

Quality Control. It is important to monitor the quality of formulations in the market and to ensure that they conform to specifications approved for registration. These specifications, if available, should be based on those of FAO[1] for pesticides used in agriculture and those of WHO[2] for pesticides used in public health.

Quality control should apply to both technical materials and formulated products whether produced locally or imported. In the case of imported material, the quality must be ascertained before acceptance by the importer. It may also be made mandatory for a valid certificate of analysis to accompany each sale of the pesticide. Quality control should continue through the market chain. The government laboratory should be charged with monitoring the quality of pesticides, and with taking appropriate action against violations. The FAO guidelines on post-registration provide valuable information on several aspects of quality control such as sampling, physical properties, storage stability, tolerance on content, and specification.

Labeling. The approval of a label must be part of a registration scheme, as the label is an indicator or legal proof at the market chain that the pesticide product is registered, and to whom the registration belongs. Governments must monitor and ensure that labeling carried out by members of the industry meets the standard agreed to and accepted by the registration authority. In addition, legislation should provide for the authorities to withdraw those products from the market that do not meet the stipulated labeling requirements, including, for example, overclaims on efficacy and safety.

The FAO's Guidelines on Good Labelling Practice for Pesticides, 1985, provide the basic requirements for labeling of pesticide containers. In addition, GIFAP's document on pictograms[3] has been reviewed and agreed by FAO to be incorporated into the labeling guidelines. (For more on pictograms and product

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1/ FAO, "The Use of FAO Specifications for Plant Protection Products", FAO Plant Production and Protection, Paper 13, Rome, 1979; and "Manual on the Development and Use of FAO Specifications for Plant Protection Products", FAO Plant Production and Protection, Paper 85, Rome, 1987.

2/ WHO, Specifications for Pesticides Used in Public Health, 6th ed. Geneva: World Health Organization, 1985.

3/ GIFAP, "Pictograms for Agrochemical Labels. An Aid to the Safe Handling of Pesticides", GIFAP, 1988.

Quality Control in Bangladesh

By **Mohammad Mazharul Haq**
Additional Director, Plant Protection, Department of Agriculture Extension

The registration of pesticides is a statutory requirement in Bangladesh, governed by the Pesticide Ordinance of 1971. The Ordinance, as well as the Amendments promulgated in 1980 and 1983, are administered by the Plant Protection Wing of the Department of Agriculture Extension, Ministry of Agriculture.

So far 157 pesticide formulations have been registered in the country; most are imported as finished products. There are five formulation plants with their own laboratories for production and quality control.

The pesticide laboratory of the Plant Protection Wing is the only regulatory agency in the country for enforcement of the relevant provisions of the Ordinance and Rules for quality control of products marketed by private companies.

If products contravene any provision of the law under which they are registered, the marketing company is subject to penalties, including the cancellation of registration.

Quality Control Practices

Post-Import. Immediately after clearing the imported consignment of pesticide, the importer informs the Director of the Plant Protection Wing to collect the sample from his premises. Pesticides are not permitted to be sold until a satisfactory test report has been issued by the Director.

Local Formulation. After completing the formulation of certain batches of a product, the formulator notifies the Director of the Plant Protection Wing. Until receipt of a satisfactory test report is issued from the laboratory, the product is not released for sale.

Random Field Surveys. Dealers distribute pesticides in small, prepackaged and labeled containers to end users throughout the country. Random samples of all these products are collected from the dealers' shops by Extension Officers. Action is taken against the dealers if test reports show the product to be defective.

Monitoring

As authorized by the Pesticide Ordinance, samples are collected by trained officers and sent under sealed cover to the Central Plant Protection Laboratory. Chemists then analyze the sample to determine the active ingredient and other physical and chemical properties of the product. If the product does not conform to approved specifications, the following actions are taken:

- The imported product is not released for marketing and sale.
- In the case of a locally formulated product, reformulation to correct adjustment of the recipe is suggested before the product is released for sale.
- If the samples collected from the dealers' shop show the product to be defective, suppliers are advised to withdraw that particular batch from the market.

- If, on the other hand, an adulterated sample has been collected from the dealers, legal action under the Penal Code is taken against the offender, and the dealer's license is cancelled by the Registration Authority.

Further, to ensure that packing and labeling of the pesticide containers conform to regulations, authorized officers of the Agriculture Extension Department conduct periodic investigations of dealers' shops, examining package size, net content and information furnished on the label. Deviations found are reported to the Registration Authority for proper action. If, as sometimes occurs, an expired product is detected, its sale is prohibited.

Enforcement

The following officers are responsible for carrying out the quality control activities:

- The Chemist of the Plant Protection Wing and his staff are responsible for collecting samples for the post-import and local formulation analyses. They also collect samples directly from dealers' shops.
- The Deputy Director, assisted by Subject Matter Specialists (SMS-PP), is responsible for quality control at the district level.
- The Subject Matter Officer and Plant Protection Inspector are responsible for the subdistrict (*Upazila*).

The above officials are specially trained in the field of plant protection and pesticides rules.

Current Problems

The pesticide laboratory in Bangladesh is insufficiently equipped with modern equipment such as an HPLC, UV spectrophotometer, GLC with NPD, and fume cupboard, without which it is not possible to analyze certain products and some of the newer active ingredients. In addition, difficulties in obtaining chemicals, reagents, analytical grade pesticides, and replacement parts for the equipment are often encountered Lack of servicing facilities by qualified technicians to repair analytical instruments is another serious problem facing the laboratory.

Another problem in ensuring quality control is encountered at the level of the end user. Fifteen marketing companies sell about 60 different brands of pesticides in the market and there are about 18,000 dealers nationwide. Some dealers take advantage of the farmers, especially in the more remote rural areas, by selling them adulterated products at a lower cost.

labeling, see Pesticide Labeling and Pictograms, p. 61 of this volume).

Although the content of the label is controlled at the point of registration of a product through legislation, compliance with label directions and warning statements must be monitored. Monitoring should begin at retail outlets and continue through field surveillance during all stages of handling, including storage and application.

Pesticide Residues in Food

Residue monitoring data provides the basis for modifying use patterns, restricting or cancelling

Quality Control in India

By **Manohar Lal Saini**
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The import, manufacture, transportation, distribution, sale and use of insecticides are regulated under the Insecticides Act, 1968. Registration of insecticides is the responsibility of the Central Government, while the licensing of manufacturers and dealers and field level enforcement is entrusted to the State Governments, with the latter being conducted by licensing officers, an appellate authority, insecticides analysts and insecticides inspectors. Inspectors are responsible for enquiry, examination, drawing of samples, detention and seizure of suspected stocks, and launching of prosecutions against offenders.

Registration Objectives and Scheme

The basic objective of India's registration scheme, and the responsibility of the regulatory agencies charged with enforcing that scheme, is to ensure that only safe and effective pesticides are introduced in the country. To achieve this end, registration authorities review data relating to chemistry, packaging, bioefficacy and toxicology of the pesticides to be considered for registration. As per the provisions of the Insecticides Act, registration for insecticides is granted under Section 9(3) after satisfying efficacy and safety requirements. Where, on the basis of available data, it is considered desirable to allow the introduction of pesticides on a provisional basis, provisional registrations are granted under Section 9(3B) for a period of two years. Once a product has been registered under Section 9(3), any successive applicant seeking registration for the same product is entitled to such registration under Section 9(4), without submission of any efficacy or toxicity data.

Licensing of Manufacturers/Formulators

A manufacturing license is required before products can be manufactured or marketed. The licensing officer/authority first ascertains that the manufacturer is not only able to produce quality material but is also

registered uses, and/or taking enforcement action against misuse. At least one government authority should be responsible for analysis of residues for follow-up action. Monitoring residues on food commodities can protect consumers of treated food and minimize problems of excessive residues on export commodities.

Maximum residue limits are established by the Codex Alimentarious Commission, and countries are encouraged to follow these levels in their legal requirements, in particular for international trade. In most developing countries, the establishment of MRL's follows the establishment of a registration scheme and, therefore, can be considered a post-registration activity, at least during the early stages of pesticide control. It is essential that reference be made to FAO guidelines which provide information on the conduct of proper trials involving crops and farm animals intended for the production of food.[4] The design of residue trials, proper sampling methods, proper packing and storage of samples, analytical requirements and reporting of results are discussed in the guidelines.

4/ FAO, "Guidelines on Pesticide Residue Trials to Provide Data for the Registration of Pesticides and the Establishment of Maximum Residue Limits", Rome, 1985.

able to sustain this process through necessary infrastructural facilities such as a suitable laboratory for testing production batches.

System of Sample Collection by Insecticides Inspectors

Once registered and permitted for manufacture/formulation, the product is subjected to an important regulatory requirement: monitoring for quality. Insecticide inspectors are empowered to collect samples of any insecticide, and to send such samples to the insecticides analysts. The process for collecting samples and for enforcing quality control is outlined in the legislation.

Analysts Facilities and State Pesticides Testing Laboratories

Samples collected by the insecticide inspectors must be analyzed by the insecticide analysts. To satisfy this requirement, State Pesticides Testing Laboratories must be equipped with both the equipment and manpower necessary for testing a large number of samples. An increase in the number of such laboratories in the States and the present capacity of analysis is indicated if effective quality control of pesticides is to be ensured.

Training and Extension

The training of analysts is a basic requirement for ensuring that the results of the analysis are acceptable and that proper analytical methodologies have been followed. Therefore, the Central Plant Protection Training Institute (CPPTI) in Hyderabad trains analysts and State Government officials, and offers a three-month Pesticides Formulation Analysis Course on the analysis of commonly available formulations. Based on the requirements of various State Departments, special training programs are also organized by the Institute, including training of the insecticides inspectors. Further, a Government-organized undertaking, Hindustan Insecticides Limited, is organizing training courses on different aspects, including formulation technology and quality control. Representatives from pesticide industries, both from within and outside the country, are invited to participate.

Environmental Monitoring

After a pesticide has been used for some time, it is desirable to confirm that the predictions about the environmental effects made at the time of registration are valid. The absence of harmful effects may permit the extension of registered uses while doubts on the validity of predictions may require that the continued use, or the conditions for use, be reconsidered.

Surveillance should be made of the residue levels in the various compartments of the environment to provide information on the distribution pattern of the chemical. Biological monitoring can be carried out by assessing population changes of key indicator species. The FAO guidelines on environmental criteria provide useful information on pre-registration hazard evaluation and prediction, post-registration activities, and appropriate test procedures.[5]

Training Programs on the Safe Use of Pesticides

The wide use of pesticides, even in remote areas, emphasizes the need to ensure that safety information

5/ FAO, "Guidelines on Environmental Criteria for the Registration of Pesticides", Rome, 1985.

reaches the individual users. While the text of the product label contains handling information and warnings against misuse, careful reading and observance of these warnings is not assured.

Therefore, training in the safe and effective use of pesticides is an important post-registration activity and should be aimed at all levels, namely: workers in pesticide plants; those stocking the shelves; retailers; farmers and other users; government technicians and extension workers; commercial pesticide applicators; doctors, nurses and paramedics; and the general public. Several FAO guidelines provide useful information on training. Reference may also be made to the training modules prepared by GIFAP for the training of farmers and retailers.

Licensing

The licensing of individuals such as pest control operators who handle pesticides, some of which may be for restricted use, would help to ensure effective enforcement of registration policies and other rules and regulations on pesticides. In addition, by licensing the premises where pesticides are manufactured, formulated, packed or stored, hazards to workers within the premises and contamination of the environment could be minimized.

The FAO guidelines on retail distribution of pesticides provide practical guidance on general precautions and facilities required for safe handling of pesticides; procedures for cleaning up of spills; as well as the proper storage of pesticides in retail outlets and godowns including the structure and facilities of such premises.[6] These guidelines have been developed particularly for use in developing countries, and can therefore be usefully incorporated into legislation pertaining to the storage and handling of pesticides.

Disposal of Pesticides

Empty containers and unwanted pesticides can be serious hazards if not disposed of properly. To minimize problems with disposal, the farmer should be encouraged to purchase only the amount needed to treat the crop. The first choice in disposing of an excessive pesticide is to use it up. If the pesticide is diluted, double spraying of a small part of the crop or spraying of an adjacent field can be carried out, provided it does not pose other problems such as excessive levels of residues on the crop.

The ultimate aim of any disposal action is to render the pesticide permanently harmless to all life forms. Disposal methods may be physical, chemical or biological; details on the disposal of pesticides and their containers on the farm have been provided by the FAO.[7]

Control of Advertisements

Advertisements may be controlled as a condition of registration, or specific regulations may be formulated to ensure that there are no misleading statements or overclaims on safety or efficacy of a product. Reference should be made to Article 11 of the International Code of Conduct.

Other Activities

On completion of registration, several other activities must be carried out to enforce registration effectively and to minimize possible deleterious side effects arising from each pesticide under actual handling and use conditions. Several of the FAO guidelines, and the International Code of Conduct provide either direct or indirect guidance on such subjects as prohibition of imports; prohibition of manufacture; investigation of poisoning cases; and the establishment of a poison information center.

6/ FAO, "Guidelines on Retail Distribution of Pesticides, with Particular Reference to Storage and Handling at the Point of Suppiy to Users in Developing Countries", Rome, 1988.

7/ FAO, "Guidelines for the Disposal of Waste Pesticide and Pesticide Containers on the Farm", Rome, 1985.

Quality Control in the People's Republic of China

By Zhang Chunjuan
Deputy Director of the Institute for the Control of Agrochemicals, Ministry of Agriculture

The People's Republic of China is a large country, with nearly one million sq km under agricultural cultivation. In recent years, since the implementation of the policy of reform and opening to the outside world, a great number of farm laborers have transferred to township enterprises and multiple cropping practices have been introduced. The latter has resulted in a rapid increased demand for pesticides. The number of pesticide plants in the country increased to about 400 including active ingredient manufacturers and formulation plants, as well as those for mixture products. The annual increased output of pesticides grew to 20,000 tons in terms of active ingredients since 1985 and the total output increased to 167,000 tons last year. Nearly 200,000 tons of pesticides are expected to be manufactured this year. Despite these increases however, production cannot meet demand.

Because of the serious shortage of pesticides, and because there is no pesticide law or penalty articles in the existing regulations for pesticide registration, many fake and inferior products as well as unregistered products have reached the pesticide market. These have caused not only ineffective control of plant pests and diseases but also heavy phytotoxicity and crop losses. For example, in 1988 nearly 40,000 tons of cotton were damaged by a poor quality insecticide containing 2, 4-D. Therefore, the country's main task in regulating pesticides now and in the coming years is to strengthen enforcement and improve pesticide quality.

To accomplish this, the following measures are expected to be, or have already been implemented prior to the establishment of pesticide legislation.

- As of 1 March 1989, the production of pesticides has been required not only for registration but also for obtaining a production permit. It is a common practice in the PRC for one active ingredient to be produced by a number of plants. To strengthen the control of pesticide production, those who intend to produce a registered product must first obtain a production permit.
- As of 1 January 1989, pesticide marketing has been monopolized by the Government. To prevent fake and/or inferior products from entering the market, the Agricultural Production and Means Corporation is the only organization responsible for the distribution of pesticides; other companies or persons are not allowed to supply or sell pesticides.
- The supervision and control of the pesticide market is to be strengthened. There is a pesticide quality control supervision system in the country comprising the central Institute for the Control of Agrochemicals (ICA) and 17 provincial ICAs located in the main pesticide producing and application areas. The central ICA – the Institute for the Control of Agrochemicals of the Ministry of Agriculture (ICAMA) – is also a national center for the supervision and inspection of pesticide quality. ICAMA is responsible for setting the national specifications for pesticides, training staff for pesticide quality control, arbitrating the main disputes of pesticide quality, and supervising and inspecting the quality of large quantities of pesticides. The provincial ICAs are responsible for supervising the local pesticide market, examining the quality of the registered products and dealing with accidents caused by fake and inferior products. In 1988, over 1,400 samples were checked by the central and local ICAs.
- Finally, training of pesticide quality control personnel with the purpose not only to improve their skills of analysis but also to enhance their confidence and authority, is to be strengthened. To this end, a national training course on pesticide quality control has been held annually since 1984. In 1989 this course was held from 17 April to 6 May in Nanjing and was sponsored by the GCP/INT/457/JAN Project. Twenty participants from 18 provincial ICAs attended.

Laboratory Requirements for Regulatory Purposes

By **Gero Vaagt**
Malaysian-German Pesticides Project, Department of Agriculture, Malaysia

Well-equipped laboratory facilities for conducting various analyses and tests (chemistry, residues, toxicology, efficacy, environmental impact) prior to the registration of the pesticides, as well as for conducting post-registration activities, are required for the introduction and effective enforcement of legislation to regulate pesticides. In this paper, some general and specific requirements in the setting up of a laboratory for the analysis of pesticides are described.

General Aspects

As the findings of a pesticide laboratory generally have national as well as international impacts and challenges, it is essential that the following areas be considered carefully prior to the establishment of a pesticide laboratory. In general, the principle of good laboratory practice (GLP) should guide all analytical work.[1]

Personnel. The analysis of pesticides and of the data obtained in pesticide-related studies requires trained personnel, often with university or tertiary backgrounds, and a group of well-trained laboratory assistants or technicians. The nature of the field warrants some basic knowledge in chemistry as well as a specialization in one area, such as in residue analysis or formulation control.[2]

Infrastructure. The purchase of equipment should depend on the assurance of continuous and reliable maintenance facilities. It is also important to have a regular supply of gas, chemicals, glassware, and other perishables as well as a constant supply of electricity and water.

Priorities. It is also necessary to identify the areas of work, to set priorities in the analytical approach, to introduce a system for the disposal of laboratory wastes and unwanted pesticides, to incorporate quality assurance programs to ensure reliable results, and to establish a system for the reporting and monitoring of test results.

Formulation Control

The production and formulation of a pesticide of high quality is the best assurance for good agricultural practice. The responsibility to guarantee the quality of formulated pesticides lies with the manufacturer.[3] A laboratory for formulation control has two major functions:

- to support registration through the analysis of the product to be registered with regard to its active ingredients, its chemical and physical properties, its solvents and contaminants, and its storage stability; and
- to support the enforcement of pesticide quality by analyzing pesticide samples which are collected at random or on suspicion.

1/ W. Weinmann, et. al. Rueckstandsuntersuchungen - Richtlinie zur Durchfuehrung der Analysen - Merkblatt Nr. 58, Biologische Bundesanstalt, Braunschweig, 1983.
2/ Ibid.
3/ FAO, International Code of Conduct on the Distribution and Use of Pesticides, Rome, 1986.

The analytical techniques should include spectrophotometry, gas chromatography and high performance liquid chromatography (HPLC) which has recently been proven to be a versatile and appropriate technique for the analysis of active ingredients. Thin-layer chromatography (TLC) is also useful for determining the purity of the products. Only internationally acceptable methods of analysis should be used; if these methods are not available, details of an alternative appropriate method must be provided by the manufacturer.

Details on the information required for the formulation control of a product are listed in the FAO Guidelines.[4] Especially in tropical countries the determination of storage stability under local packaging and storage conditions is of great relevance. For the identification of unknown active ingredients, a collection of gas-chromatographic retention time data could be used.[5]

Besides these analyses, in-house quality assurance as well as external quality control, e.g. through ring-analysis and collaborative studies, should be part of the routine laboratory procedures.

Well-established laboratories should also consider the use of equipment such as a mass spectrometer to analyze and confirm the chemical structure of the compound.

Bioefficacy Evaluation

The evaluation of the efficacy and the crop safety of a product is an essential part of the registration process. These evaluation trials are normally carried out in the field although a certain amount of data such as studies on resistance, can be obtained through laboratory evaluation. To support the field evaluation, technical equipment for the identification of pests and pathogens is required. In addition, the evaluation of household pesticides also requires laboratory facilities such as spraying chambers and installations for insect rearing.

Residue Control

The analysis of pesticide residues in support of pesticide registration has two major functions:

- to establish the MRL and the pre-harvest interval (PHI) for the specific crop; and
- to monitor the occurrence of pesticide residues in crops, livestock and the environment.

Degradation studies using single residue methods fulfill the first function, while multi-residue methods have been proven to be very useful for any monitoring programs.

Gas chromatography (GC) remains as the main analytical technique. For a wide range of herbicides the HPLC-technique is recommended. These chromatographic analytical instruments are equipped with selective and specific detectors such as the electron-capture detector (ECD), nitrogen-phosphorus detector (NPD), flame-photometric detector (FPD) in the GC, and the fluorescence detector and the ultraviolet (UV) detector for the HPLC. The detection limit of the analysis is in the region of mg/kg and μg/kg (ppm and ppb) and requires these sensitive detectors as well as good clean-up procedures and specific columns for clear separation of the various compounds.

The adoption of a residue method into the routine analytical program of a residue laboratory needs careful and intensive preparation to optimize every step of the analytical procedure. For example, the extraction and the clean-up method must be efficient to achieve a satisfactory recovery of the residue in the chosen matrix.[6]

4/ FAO, Guidelines for the Registration and Control of Pesticides (including a model scheme for the establishment of national organizations), Rome, 1985.

5/ S. H. Tan, et. al., "GLC-Relative Retention Time Data of Pesticides for Identification of Unknown Active Ingredients", Proceedings of International Conference on Pesticides in Tropical Agriculture, Malay Agricultural Research Development Institute (MARDI), Kuala Lumpur, September 1987 (in print).

6/ Weinmann, op. cit.

Laboratory Equipment and Manpower for Formulation Analysis in the Republic of Korea

By **Han-Kyu Lee**
Agricultural Chemicals Research Institute, Rural Development Administration

Formulation analysis of all pesticides in the Republic of Korea, whether imported or formulated in country, is conducted first by the formulation or import companies, followed by the National Agricultural Materials Inspection Office (NAMIO). All analysis is done prior to distribution. The "self-inspection" by the formulators and importers includes analysis of both chemical and physical properties of the products, and is conducted on such areas as active ingredient, emulsification, water solubility, hydration, powder size, pH, specific gravity, surface tension, heat-resistance, cold-resistance, suspension state, dispersion, and chemical stability. Results of the analysis and a certificate of its completion are submitted to NAMIO.

Because the analysis is extensive, formulators or importers are required to employ specialists and technicians to analyze the chemical and physical properties of their pesticides and are required to staff an analytical laboratory equipped with chemical balance, dry oven, furnace, refrigerator, water bath, spectrophotometer, gas chromatograph, vacuum pump, mili-Q system, standard sieves, hydrometer, and surface tension meter.

NAMIO regularly inspects random samples of pesticides after distribution. If deemed necessary to ensure quality control, NAMIO may also conduct bioefficacy tests on the pesticides concerned. Samples are tested within one month of collection. Pesticides assessed as inappropriate are gathered and reformulated, or disposed of by formulators or importers in accordance with the batch number of products.

Twenty-four specialists and technicians are employed by NAMIO to conduct the chemical and physical analysis of pesticides. The following laboratory equipment is available at NAMIO: gas chromatograph; high performance liquid chromatograph; spectrophotometer; preparative high performance liquid chromatograph; thin layer chromatograph; milipore system kit; voltex mixer; laser micron sizer; ultra centrifugal mill; and others (chemical balance, binocular microscope, surface tension meter, magnetic stirrer, dry oven, shaker, shaking water bath, incubator, refrigerator, furnace, vacuum pump, mili-Q system, standard sieves and hydrometer).

Quality control of the results generated by means of intra-laboratory and inter-laboratory checking (ring analysis) has to be given the highest priority and various organizations offer programs for this purpose.[7]

Toxicology and Environmental Behavior

The assessment of risk to man and the consideration of all impacts of the pesticide require appropriate and extensive tests. The conduct of these tests must follow the guidelines developed by the Organization for Economic Cooperation and Development (OECD) and those of GLP,[8] and demands a sophisticated laboratory set-up.

In general, the evaluation of toxicology data is based on paper evaluations only. To measure the impact on the local environment, certain tests can be carried out, such as fish toxicity test by using a suitable local fish species and following the OECD guidelines. These tests require only basic laboratory equipment. (For more on fish toxicity tests, see p. 47 of this volume.)

7/ Good Analytical Practice (GAP), Report of the 15th Session of the Code Committee on Pesticide Residues, The Hague, 3-10 October 1983, (Appendix V, Annex II).

8/ Good Laboratory Practice, C (81) 30, Annex II. OECD, Paris, 1981.

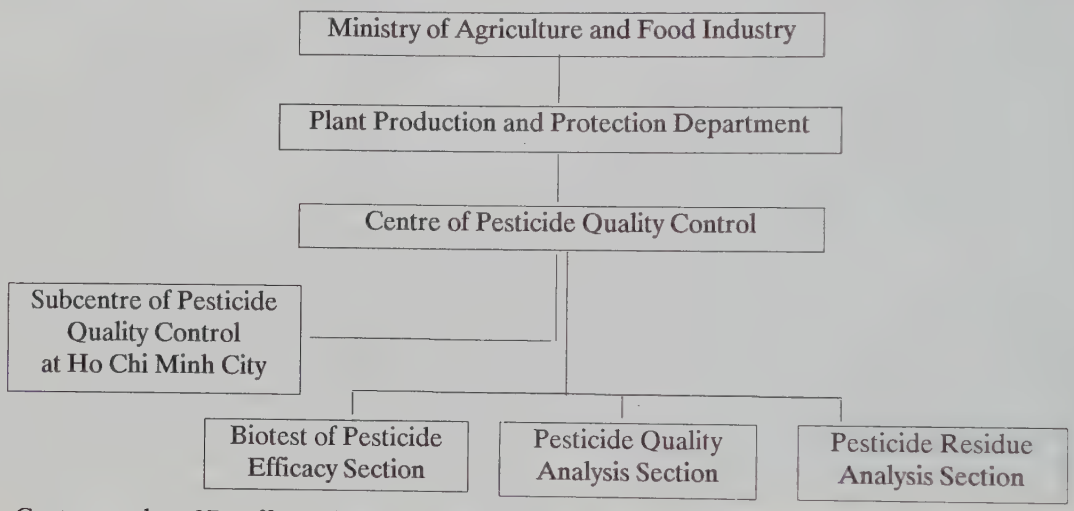
Quality Control in the Socialist Republic of Viet Nam

By **Bui Van Ich**
Director, Plant Production and Protection Department

Although pesticide legislation has not yet been enacted formally, a system of pesticide control has been implemented in Viet Nam which follows the provisions of the Code of Conduct on the Distribution and Use of Pesticides. In particular, the country has instituted pesticide quality control through the Centre of Pesticide Quality Control under the Plant Production and Protection Department (PPPD). The organization and activities of the Centre are discussed below.

Organization and Function

The Centre was established on 27 December 1984 under the Plant Production and Protection Department, Ministry of Agriculture and Food Industry.


Ministry of Agriculture and Food Industry
Plant Production and Protection Department
Centre of Pesticide Quality Control
Subcentre of Pesticide Quality Control at Ho Chi Minh City
Biotest of Pesticide Efficacy Section
Pesticide Quality Analysis Section
Pesticide Residue Analysis Section

The Centre employs 27 staff members. Of these, 22 hold Bachelor of Science degrees and 7 are analysts.

With assistance from FAO and UNDP and investment from the Government, the Centre has been equipped with modern equipment such as gas liquid chromatography, high-performance liquid chromatography and UV spectrophotometry. Equipment for pesticide residue analysis will be supplied by the FAO Project VIE/88/031.

The Centre assists PPPD in the following ways: (i) tests the efficacy of pesticides to determine which can be used in Viet Nam; (ii) controls the quality of pesticides; and (iii) analyzes pesticide residues in soil, water and on agriculture products.

Activities of the Centre

Efficacy Testing. The Ministry of Agriculture and Food Industry requires that all pesticides be tested for efficacy prior to registration and use. The Centre is responsible for organizing and implementing this test, and for establishing the protocols for pesticide efficacy trials in the fields and the laboratory, in collaboration with different regions' research institutions. The results of such tests are the basis for decisions concerning

Socialist Republic of Viet Nam, continued

importation, formulation and use of pesticides in the country and, ultimately, for the recommendation of pesticide application.

A seminar on pesticide efficacy testing is held every six months to train staff, and report test results, as well as to provide staff the opportunity to exchange experiences.

The Centre has tested 81 pesticides including insecticides, fungicides, bactericides, rodenticides and herbicides from various pesticide companies throughout the world, including Japan, France, England, Germany, and Switzerland. Fifty-one pesticides have been approved for use in Viet Nam; of these, 20 are widely used.

Pesticide Quality Control. The principles governing quality control in Viet Nam are outlined below.

- Pesticides introduced or formulated in the country should be tested for quality before distribution and use.
- Pesticides which do not meet the country's quality control standards should be returned to the consignee for reformulation. If the pesticide is accepted without reformulation, the cost of the product should be reduced and guidance on its application should be provided to the farmers.
- At each pesticide delivery point there is one staff member trained in the technique and principles of pesticide sampling. This individual is responsible for collecting and sending samples to the Centre, where the actual quality control tests are applied. The completed analysis (physical, chemical feature, content of active ingredient, packaging and labeling) is then recorded and the pesticide quality certification issued.

Many of the pesticides used in Viet Nam can be analyzed by the Centre, which is equipped to analyze 3,000-3,500 samples annually.

The methods of the Collaborative International Pesticides Analytical Council Limited (CIPAC), as well as the specifications established by FAO and the Government, some of which are worked out by the Centre, have been adopted to control the quality of pesticides. Through the implementation of these quality control measures the country has reduced the number of substandard pesticide consignments and increased the sense of responsibility of the formulators.

Pesticide Residue Analysis. The objectives of pesticide residue analysis are as follows:

- analyze pesticide residue on exported agricultural products;
- study the pesticide residue in crops to determine their pre-harvest intervals;
- analyze the pesticide residue in agricultural products to ensure levels do not exceed those determined as safe for humans; and
- analyze pesticide residue in soils and water to ensure environmental protection, particularly that of the agroecosystem.

As equipment and the number of staff are limited at the Centre, only one of the above-mentioned objectives is carried out on exported agricultural products — bananas, pineapples, oranges, peanut, soybean, rice, tea, and coffee. So far, no consignment has been detected to be over the maximum residue limit.

While the Centre has played an important role in the implementation of the Code of Conduct on Distribution and Use of Pesticides, efforts should be made to further develop and implement the following activities:

- upgrade equipment for the Centre of pesticide quality control, particularly for the pesticide residue laboratory;
- upgrade the methods of pesticide analysis and efficacy test protocols for pesticides, following international and regional standards;
- provide training for staff on pesticide analysis and maintenance of equipment; and
- improve the cooperation and exchange of experience with FAO and other international organizations.

Conclusion

The setting up of a laboratory in a developing country in support of registration is an important and necessary step in strengthening and improving the control of pesticides. Countries where such facilities are not available should have access to laboratory services. Priorities should be given to formulation control and bioefficacy evaluation followed by degradation studies and monitoring programs for residue control and the assessment of the toxicological and environmental impacts of the pesticides.

With the implementation of an operational laboratory, pesticide use in a country can be more successfully regulated to ensure the supply of good quality and effective products which in turn supports the safe and efficient use of pesticides.

Quality Assurance in Testing Laboratories

By **Donald J. Hannah**
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Laboratory accreditation schemes involve the implementation of good laboratory management practice and laboratory quality assurance programs in accordance with the criteria and assessment of national accreditation authorities. The successful assessment of a laboratory enables it to be endorsed by the accreditation authority and provides the user of the report with confidence that the data reported has been produced under the principles of good laboratory quality assurance. Laboratories are registered for a defined range of tests and types of tests, and report endorsements can only be made on certification relating to this range of tests.

Laboratory Quality Assurance Programs

Laboratory quality assurance can be defined as the demonstration of a laboratory's ability to perform to the necessary standard the work it is required to undertake; i.e. demonstration of the assurance a laboratory has of its quality. This means that the methods, staff, accommodation, procedures and equipment are appropriate for the tasks and tests required. As many commercial, economic, social, health and environmental decisions are based on analytical data, it is important that a laboratory can demonstrate the level of quality assurance it has, and that this can be subjected to an independent, external, audit.

The laboratory must implement procedures of good laboratory management practice. These procedures relate to the organizational processes, resources, facilities, staff and conditions under which laboratory tests are planned, conducted and reported.

Organizational processes relate to the ownership and operation of a laboratory, the responsibility and the accountability of the laboratory management. Resources cover a wide range of requirements, from having adequate funds for conducting the tests required, to having access to consumable chemicals and adequate gas, electricity, and water supplies. Access to technical support for instrument maintenance is also necessary.

For pesticide analysis it is inappropriate to carry out pesticide formulation quality control testing in the same laboratory as is used for pesticide residue testing in foods and the environment. The organizations that undertake these two functions must, therefore, arrange the laboratories in a manner that avoids the potential for cross contamination and spurious results.

In addition, staff requirements are many and varied. The overriding requirement is that the supervisory staff be adequately trained in the discipline to which the testing relates. For most pesticide laboratories, the supervisory staff should have a basic training in chemistry, as well as a good knowledge of organic chemistry and of the principles of analytical chemistry. On-the-job training or other training in pesticide chemistry and analysis is also required. Technical staff usually need to have a basic technical training in a laboratory related subject, with the work initiated and supervised by the experienced staff.

The conditions under which laboratory tests are conducted and reported should be carefully and fully outlined in the appropriate manuals, both method and procedural. This ensures that the operation of a laboratory is not dependent on any one individual and that the procedures and conditions of operation are objectively defined and available.

The reporting of results is a critical aspect of a testing laboratory's function as it is the test report that communicates the result to the customer. To this end, laboratory procedures should be sufficient to ensure that the result of a test is accurately recorded, checked and reported. A laboratory should retain all records – from receipt of the sample to the final report – to enable traces and follow-up action to be conducted in the event a result is questioned.

It is in every testing laboratory's interest to implement good laboratory management practices to

minimize errors and to give confidence in the assurance that is placed in the quality of the results.

Accuracy and Precision

Accuracy and precision represent two aspects of a test result that have important consequences. The accuracy of a result, how close it is to the "true" result, is of obvious importance and a laboratory should know the accuracy it can expect from a particular test method. Precision is important when results are being compared to other results on the same sample, or with a product specification. The range of deviation from the reported result imparted by the analytical method is a measure of the precision of a method.

Laboratory Accreditation Schemes

Independent national laboratory accreditation schemes conduct assessments or audits of laboratories. These assessments are carried out by experienced and trained staff who conduct the assessment with reference to internationally agreed criteria outlined in such documents as BS 6460 and ISO Guide 25. These criteria provide outlines of the procedures that should be implemented in a laboratory, and guidelines for the assessment of them. The testing must be adequate for the purposes required. The laboratory accreditation schemes assess this adequacy, and do not expect the laboratory to operate at levels higher than that required. Laboratories should be prepared to be subjected to assessment as performance is improved.

The agencies conducting the assessments or audits may be government departments that have statutory responsibility for the quality of the product or service, such as Health or Agriculture, and hence conduct quality audits on laboratories supplying analytical data, or they may be independent authorities set up specifically to carry out these functions. Two such independent authorities are TELARC New Zealand (Testing Laboratory Registration Council of New Zealand) and NATA (National Association of Testing Authorities of Australia). These authorities are members of ILAC, the International Laboratory Accreditation Conference. ILAC provides a mechanism for liaison between accreditation authorities and for the development and standardization of the principles and practices of laboratory accreditation.

Some of the organizations in the Asian region that have responsibility for laboratory accreditation schemes, or are presently establishing such schemes, are listed below.

Country	Organization
People's Republic of China	State Bureau of Technical Supervision, National Institute of Metrology
India	National Coordination of Testing and Calibration Scheme
Indonesia	Indonesian Standards Council
Republic of Korea	Korean Association of Standards and Testing Organizations (KASTO)
Malaysia	Standards and Industrial Research Institute of Malaysia (SIRIM)
Philippines	Bureau of Product Standards, Department of Trade and Industry
Singapore	Singapore Institute of Standards and Industrial Research
Sri Lanka	Sri Lanka Standards Institution
Thailand (two schemes)	Thailand Industrial Standards Institute and Department of Science Services
Socialist Republic of Viet Nam	General Department for Standardization, Metrology and Quality Control

Monitoring the Health Effects of Pesticides

By **Nelia P. Cortes-Maramba M.D.**
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The regulatory agency tasked with monitoring the health effects of pesticides must ensure safety in use of these pesticides among those handling the products and must also institute the steps necessary to protect the general public from ill effects due to high residues in food and the environment. This paper will concern itself with monitoring the health of workers directly exposed to pesticides and, to some extent, to the monitoring of acute poisoning cases.

Occupational health programs for pesticide handlers must consider not only the health of the workers in the pesticide industry but the larger work force in the agricultural sector as well, the majority of whom are self-employed and more difficult to "regulate and control" than those employed in agricultural institutions or plantations, in formulating/manufacturing plants or in public health for vector control.

Therefore, the best approach to health monitoring of pesticide handlers is through an integrated, multi-disciplinary approach. The Department (or Ministry) of Health and Labor must be involved in establishing the program and policies, and monitoring programs must be planned and instituted with their cooperation. Further, it is necessary to institute an agromedical approach. For example, in Indonesia, Dr. Iwan Darmansjah approached the problem of pesticide poisoning through the development of pesticide protection teams consisting of a medical doctor, a technologist (or pharmacist or chemist with capability to do thin layer chromatography tests and cholinesterase determinations), a sanitarian trained in public health activities and agricultural extension workers. The major responsibilities of these pesticide protection teams were to establish a chain of command for environmental monitoring (especially for agricultural chemicals) and for the investigation and chemical verification of episodes with possible relation to environmental pollution and poisoning due to pesticides. These pesticide protection teams operate in all 26 provinces, reporting to a "Central Health Team" supervised by the Surveillance Team of the Department of Health in Jakarta.

In countries with manpower trained in occupational health (industrial hygiene, public health, ergonomics, occupational medicine), a more in-depth approach can be instituted.

An occupational health program, including that concerned with pesticide handlers, aims to promote and maintain the optimum health of the worker. This can be achieved through the following specific objectives:

- identify and bring under control at the workplace all chemical, physical, mechanical, biological, and psychosocial agents that are known or suspected to be hazardous;
- ensure that the physical and mental demands imposed on people at work by their respective jobs are properly matched with their individual anatomical, physiological and psychological capabilities, needs and limitations;
- provide effective measures to protect those who are especially vulnerable to adverse working conditions and also to raise their levels of resistance;
- discover and improve work situations that may contribute to the overall ill health of workers to ensure that the burden of general illness in different occupational groups is not increased over the (unexposed) community level;
- educate management and workers to fulfill their responsibilities relevant to health protection and promotion; and

- conduct comprehensive in-plant health programs (or among farmers in the agricultural sector) dealing with man's total health which will assist public health authorities to raise the level of community health.

Of course, while in most occupational health programs health risks may be eliminated completely, in others (including those involving pesticide handlers) health risks can only be reduced to acceptable levels. Therefore, to achieve the specific objectives of an occupational health program, the important activities to implement are workplace environmental monitoring and medical monitoring.

Such monitoring should be based on the following objectives:

- assess recognized occupational health risks and evaluate their control by (i) providing the data necessary to ensure that environmental protective action is initially taken against health risks and to ensure that workers are placed in jobs suited to their capabilities; (ii) providing continuing evaluation to ensure that adequate protection is maintained; and (iii) obtaining an accumulating body of data for epidemiological use to show the comparative effectiveness of the engineering and medical aspects of preventive programs and, where appropriate, to permit the redefinition of permissible levels of exposure;

- identify occupational health risks not previously recognized so that steps can be taken to control them, such as establishing permissible levels of exposure;

- reveal other sources of health risks, especially those associated with stresses that do not cause occupational disease but increase psychological vulnerability and possibly contribute to general ill health;

- identify and promote factors that are beneficial to health; and

- provide information on community health problems (not primarily caused by work) by observing the gainfully employed, who form a significant part of the general population.

In the case of pesticide handlers, there are differences between exposure during production and exposure during application, as is shown in Table 8 below.

Also, adverse health effects of pesticides vary depending on the categories of exposure. Acute and incidental exposure result in systemic or topical poisonings, the toxidromes of which are usually related

Table 8. Exposure During Production and During Applications

	Exposure During Production	Exposure During Application
Exposure Period	Prolonged	Temporary
Exposure Levels	Relatively easy to control variations usually fairly small	Large variations (dispersive use)
Skin Penetration	Relatively easy to control	May be high (dependent on work practices)
Air Monitoring	Useful	Relatively difficult (except if spraying is done in enclosed places)
Biological Monitoring	To be combined with air monitoring	Probably the more relevant monitoring method, if available
Combined Exposure	Some factors easier to control than others	Frequent control impossible

to the toxicity of the pesticide, whereas chronic occupational exposure among the workers results in varied organ-system involvement which may not be recognized or manifested until several years of exposure to certain pesticides.

Environmental Monitoring or Occupational Hygiene Monitoring

Environmental monitoring is involved with assessment of the workplace to measure the dose of the hazardous agent absorbed by the worker. Among pesticide handlers in manufacturing/formulating plants the two important factors that can minimize hazards in pesticide handling are appropriate engineering controls and good industrial and personal hygiene. In the field however, the most important protective measures are the use of personal protective clothing and equipment and good hygienic practices.

A program on workplace monitoring must include the following:

- organizational aspects — These should focus on the chain and designation of responsibility especially as regards occupational health, industrial hygiene, safety control, engineering control and the formation and activities of a safety committee. Personnel training and internal audit activities should be included.

- industrial hygiene — This is concerned with ventilation, lighting, use of personal protective clothing and equipment, laundry facilities, and good housekeeping including availability of emergency equipment in case of leakage/-spillage. Good engineering control is an important aspect of industrial hygiene.

- safety and security control — This includes the capability to control fire, proper storage of raw materials and finished products, availability of eyewash facilities, shower facilities with separate clean and dirty areas for changing clothes and separate eating areas for workers.

Environmental protection at the formulation/manufacturing plant or agricultural plantation should be checked for the presence of (i) bunding walls to prevent spillage of pesticides to the outside, (ii) a central sewerage tank which can be decontaminated prior to flowing to the general sewerage, (iii) proper disposal of used containers and unused or obsolete pesticides, (iv) presence of anti-pollution devices such as the use of filter/scrubbers, and (v) proper plant location.

Ideally, the pesticide regulatory agency would be consulted prior to the construction of pesticide manufacturing/formulating facilities so that compliance with the requirements of occupational hygiene could be implemented.

Environmental Evaluation

Compliance to proper occupational hygiene can be determined through sampling and measuring techniques for pesticide levels at the workplace. Of course the approach or sampling procedures/techniques vary depending on the type of hazard being monitored. For example, in the assessment of exposure causing immediate illness, the most important index of hazard is the brief exposure to high concentrations of the chemical. On the other hand, if exposure producing cumulative effects over a long period is to be assessed, then the level of exposure may be best determined by time-weighted averages. Sampling for levels of pesticides can be done through the use of personal samplers which can be worn by individual workers as they move in their workplace, or by using static samplers at stationary sampling points. The instruments and techniques used in workplace environmental monitoring range from the simple to the very sophisticated depending on the nature of the relationship between the hazardous agent and the resulting disease. The selection of the proper instrument and technique of monitoring is done to yield information on those characteristics of the workplace that are known to have particular significance for health and for which dose/response relationships have already been established.

Environmental pesticide monitoring outside the workplace is also an important aspect of safe pesticide management. It is essential to know whether the presence of pesticides in the environment would reduce the productivity of the land, sea, and air or would cause problems of human health. Environmental pesticide monitoring is not simple. It involves a wide range of factors for consideration: the toxicity of the chemical, the limit of detection of analytical methods,

its behavior in the environment as predicted by its chemodynamics and the need for good statistical planning. There are at least four types of environmental monitoring:

- reconnaissance monitoring which involves periodic observations with the objective of determining changes with time, with the goal of instituting corrective action if trends become alarming;
- surveillance monitoring which consists of observations that are made periodically to support an enforcement program and to ensure compliance to regulations;
- subjective monitoring or spot checking which may be undertaken to investigate accidental pesticide spills or to determine the general levels of hazard in the environment; and
- objective monitoring which is purposely planned and conducted (as in research) to develop and confirm quantitative models and simulations.

Environmental monitoring may be undertaken by both direct chemical analysis of the pesticides and measurement of biological response of living organisms. Direct chemical measurement may be made of the pesticide or its known breakdown products in soil, water and air or in tissues of animals, plants, food substances, or in man. In many instances, measurement of the specific pharmacological responses in different animal and plant species, such as assessing the effect of organochlorines on certain predator birds with egg shell thinning thus reducing hatching success and reducing their reproductive capabilities, may be more practical.

Medical and Health Monitoring

Medical monitoring or health assessment of workers is conducted to determine total health effects of exposure to physicochemical and psychosocial factors. Such monitoring can be achieved through appropriate medical examinations of workers, biologic monitoring, proper training of health personnel and workers and provision of appropriate medical facilities and adequate drugs and medical devices.

Health assessment of workers handling pesticides consists of pre-placement, periodic, and exit medical examinations which should be conducted for all workers whether hired on a permanent, contractual, or casual basis. Pre-placement medical examination has the purpose of proper job placement according to the physical and mental capabilities of workers, and serves to identify persons likely to be vulnerable to certain exposures as well as provides baseline data that would make it possible to measure early adverse effects of exposure in persons at risk (early detection of health impairment) by following changes in values from levels established at pre-placement examinations in exposed and unexposed groups.

Periodic medical examinations serve several purposes:

- detect early health impairment;
- evaluate the effectiveness of preventive measures;
- detect workers showing undue susceptibility to a particular environmental or work exposure so that immediate transfer to another work area can be instituted;
- reveal trends in the health status of groups of workers; and
- determine the need for medical treatment.

The frequency in which periodic examinations are conducted depends on the degree of hazard to which the worker is exposed.

Other medical examinations which may be needed include the following:

- transfer examinations — These are conducted on workers who will be transferred to another job (as temporary or permanent replacement) to determine their fitness to the new job.
- special examinations — These may be required where there has been undue exposure to health hazards.
- return-to-work examinations — These are conducted to determine if the worker is still contagious and to determine whether the worker is fit to return to work.
- exit or separation from employment examinations — These determine if the employee is

suffering from any occupational disease, or whether the worker/employee is suffering from any injury or illness which has not completely healed.

The scope of the medical examination and laboratory tests varies depending on the degree of hazard to which the worker will be or has been exposed. For example, if the pesticide is known to produce neurotoxicity, a detailed neurologic examination is needed. Exposure of workers to pesticides which are absorbed through dermal and inhalational routes would require not only a routine chest x-ray but pulmonary function tests, detailed dermal examinations and possibly skin testing for allergenicity especially if a positive history of allergy to drugs and chemicals is present. The frequency of periodic examinations should conform to the degree of risk to the worker and to others, as well as to the age structure and the susceptibility of the group of workers.

Human exposure to pesticides can be quantified in different occupational groups by two methods: either the direct method or the indirect method; and a combination of the two methods.

Direct methods were the first methods used to measure worker exposures to pesticides by using alpha cellulose patches for spray exposures and layered gauze patches for dust exposure. Clothing (overall or t-shirt) is used for whole body dermal exposure assessment, while the cloth bag rinse technique assesses hand exposures. Respiratory exposure can be quantified by measuring the amount of pesticide absorbed in special filter pads in single unit respirators.

In conducting these studies, whether indoors or in the field, special precautions should be taken to ensure optimum recovery of most of the pesticide residue by placing them in appropriate solvents and transporting the containers in ice (dry ice if possible). Pesticide or metabolite concentrations are expressed in mg/cm^2/hour. The number and anatomical location of patches will vary with the work characteristics being studied. It should be remembered that patches are of no value when pesticides degrade or vaporize rapidly or if the patches are contaminated with other chemicals or water.

Indirect or Biochemical Parameters for Occupational Health Evaluation

Alteration in biochemical parameters as measured in various biological materials may be among the more sensitive indicators of early changes in health due to hazardous agents in the work environment. These changes represent a reaction to exposure to the hazardous agent and in some cases may indicate an actual adverse effect on health. In other cases they may indicate compensatory mechanisms to maintain homeostasis and are usually reversible. In still other cases, they may signify minor cellular effect (or damage) for which the body's regenerative processes can cope sufficiently to preclude health impairment. It is, therefore, essential to undertake careful quantitative evaluation of biochemical parameters and to determine statistical dose effect/response relationships.

Table 9 shows the biologic indices which have been used in pesticide exposure monitoring. From an

Table 9. Biologic Indices

Type	Uses
Cholinesterase determination	Verification of cholinergic illness and monitoring worker's exposure to organophosphate pesticides.
Skin and hair residues	Verification of exposure to lead, arsenic, and mercury.
Urinary metabolites (alkyl phosphates and phenols)	Verification of exposure to organophosphates and carbamates; confirmation of acute, chronic and incidental exposure.
Adipose and serum pesticide	Verification of acute, chronic and incidental exposure to organochlorines, lipophilic organophosphates and bipyridyls.

epidemiologic point of view these indices are important for evaluating exposure and for indicating ways in which they can be reduced, e.g. as in intervention studies which evaluate the most appropriate protective clothing, or in evaluating the use of close techniques in the formulation and handling of category I and II pesticides.

Reporting of Acute Pesticide Poisoning

Pesticide poisoning statistics are vital inputs for those who are tasked with planning, importing and controlling pesticides in a country. The data provide valuable information on what chemicals can be safely used (and imported and manufactured) and which can be allowed for registration or to be re-registered.

The main problems with monitoring the reporting of acute pesticide poisoning is not only under-reporting due to nondiagnosis of actual pesticide poisoning but the absence of, or inefficient structure for standardized reporting, collection, collation and evaluation of such data.

These problems may be solved through an integrated multidisciplinary approach involving several agencies of the government, as well as by training medical and para-medical personnel on the recognition (and management) of pesticide poisoning cases, informing workers and consumers in the safe handling of pesticides, and through direct involvement and cooperation of the pesticide industry in the close adherence to the Code of Conduct on the Distribution and Use of Pesticides.

Pesticide Disposal Issues

By **Edwin L. Johnson**
Director, Developing Countries Staff, Office of International Activities, US EPA

Pesticide disposal is a complex regulatory issue. Unused pesticides, rinsates from containers or application equipment, and the empty or partially-filled containers themselves, all have the potential for environmental contamination. Proper, environmentally sound disposal techniques can be prohibitively expensive and facilities for disposal may not be available for individuals or governments, particularly in developing countries. Large and small operators, farm operations and individual homeowners represent different degrees of the problem, but all contribute to the mass of material to be disposed. Some pesticides constitute hazardous waste because of their inherent toxicity or chemical characteristics. In many instances the containers cannot be efficiently collected, reconditioned or destroyed.

Basic elements of reduction in disposal problems involve developing regulations on container design and pesticide residue removal, requiring data from pesticide producers concerning proper disposal, and requiring recalls of stocks when pesticides are prohibited from continued marketing and distribution. In large volume use areas, it may be well to focus on ways to promote bulk distribution and storage of pesticides and to reduce the numbers of smaller containers in commerce. For individual users, homeowners, and small farmers, improved design of appropriate containers suitable for their small-scale operations is the goal with emphasis on such aspects as preventing leaking containers and enhancing removal of residues. Although other techniques will be considered, triple rinsing of containers will remain the essential basic step in disposing or returning containers of liquid pesticides.

While practices for disposing of pesticides and pesticide containers varies among countries (see examples on pages 90; 91 and 92), there are some common elements regarding disposal which are significant wherever pesticides are used.

Proper use – whether by industrial, commercial or private citizens – is essential. Purchasing and mixing only the amount needed, disposing of pesticides by proper use and rotating of stocks are paramount to reducing the need for disposal. Where it is appropriate, inducement for correct action or penalties for improper disposal can be used; however, education in proper use is critical.

Individuals must understand the dangers of improper re-use of containers as food or water receptacles. Users should avoid indiscriminate dumping of residues on land or in the water, and the careless discard of containers must be avoided. These basic concepts are conveyed on the pesticide label and should be reinforced with educational programs wherever possible.

Getting end users effectively involved in proper disposal is essential. However, the effort is barren without the next level of activity, i.e. providing procedures and facilities that can properly collect and dispose of pesticide wastes and/or containers when this becomes necessary. For some operations, reconditioning of containers is cost-effective provided the user is able, and can be induced to return the article in reasonable condition for refilling. Waste disposal programs must be adequately designed to deal with the most severe problems to be encountered. In addition, these programs must be accessible. The major disposal technique in the US today is incineration of wastes under strict standards of combustion efficiency or disposal of triple-rinsed containers in landfills or burial on the farm. However, some commercial landfill operators will not accept certain pesticide wastes either because of specific provisions/requirements of US law regulating hazardous wastes or because of public outcry over the disposal operations. Land burial for large amounts of toxic wastes is no longer considered acceptable technology in the US because of potential contamination and associated liability.

As a practical measure, using a pesticide supply completely and, to the fullest extent possible, matching inventories to actual need to keep stocks at a minimum, will help to reduce the size of the disposal problem. Proper storage procedures/facilities are critical both to prohibit access by unprotected individuals or animals and to maintain containers adequately. The latter is particularly significant under extreme conditions of temperature and humidity. Pesticides improperly attended may become hazardous contaminants of the immediate environment and can lose effectiveness more rapidly than material in proper storage and hence require disposal.

Effective coordination of responsible efforts between various offices of the government can be both a practical consideration and crucial to disposal efforts. Approvals in the form of licensing of technology or procedures often occurs at the national level, but must reflect social conditions and be understood in practical terms by local citizenry.

There are a variety of disposal techniques in use or under development including cement kiln incineration, portable incineration, immobilization, detoxification, reprocessing and re-use of rinsates.

Cement kiln incineration is used in a number of countries (see Malaysia below) and is a very efficient

Pesticide Disposal in Malaysia

By **Zainal Abdul Rasol**
Agriculture Officer, Crop Protection Division, Department of Agriculture

Malaysia has no facilities for the safe disposal of unwanted pesticides and laboratory waste. Regulations governing the disposal of all chemical wastes do exist however, in the form of the Environmental Quality Act of 1974. The Department of Environment is the implementing agency for this Act and is taking steps to locate suitable sites within the country for the disposal of chemical waste.

In the meantime, the Pesticides Section of the Department of Agriculture has accumulated large quantities of a wide range of pesticides which were seized from the market consequent to the implementation of the Pesticides (Registration) Rules 1976.

Based on information obtained from Europe and the US on the use of cement factories for the incineration mainly of liquid chemical waste, cooperation was obtained from the Associated Pan Malaysia Cement factory for similar means of disposal. The conditions in the rotary cement kiln (temperatures ranging from 1200°C to 1800°C and a long combustion period) make it suitable for safe incineration of all pesticides except for those containing heavy metals.

After a period of trial incinerations of pesticides, a loading device for the direct injection of liquid pesticides and laboratory wastes was constructed. The loading device consists primarily of a 2,000 liter tank and a high pressure pump resistant to organic solvents with a pumping rate of 250 liters per hour. The pump injects the liquid pesticide directly into the burner of the rotary cement kiln; temperatures in this kiln can reach to nearly 1950°C. Residue analysis for dioxin and chlorine content of the clinker, i.e. the burnt product, in cement production and the filter dust obtained from the exhaust system was carried out. No trace of dioxin was found and the chlorine content did not differ from the normal chlorine content of the filter or that of the clinker. Samples of gases at various points ranging from the burner to the exhaust system were obtained and analyzed and there was also no difference in content from the normal gaseous waste.

Trials are now being conducted on the combustion of solid pesticide waste, and analysis of the clinker and effluents will be carried out.

While the Department of Environment had approved this method of disposal, they stipulated several conditions, such as maximum chlorine content in the exhaust gases and prohibition of disposal of heavy metals, which, based on the data obtained so far, can be fulfilled.

Pesticide Disposal in Sri Lanka

By **Nallini De Alwis**
Registrar of Pesticides, Department of Agriculture

The safe disposal of unwanted, time-expired and/or damaged pesticides and empty containers is a problem in Sri Lanka as the facilities and the technical know how to accomplish disposal are limited. The points at which disposal problems arise and the types of materials requiring disposal are given below:

- at formulation plants and repacking units: unwanted technical material and/or formulated products, inclusive of imported off-specification products or prohibited pesticides, solid wastes such as empty bulk containers — steel and plastic — and adsorbent material used in spills.
- at various points of the distribution network both in the private and public sector: outdated retail packs and unregistered products.
- on government farms and estate stores: outdated products and empty retail packs.
- at the end users level: empty retail packs.

While there has been an ongoing educational program on the disposal of empty retail packs which has been further reinforced by the mandatory requirement to retail pesticides in special containers to prevent re-use, the progress in the disposal of unwanted technical concentrates, formulations, outdated retail packs and empty bulk containers has not been marked.

The various measures initiated to contend with the problems of disposal include educational programs, incentives and incineration.

- Educational programs on disposal include:
  - messages stressing the need to prevent re-use of empty retail packs either by crushing or burial;
  - lessons on how to minimize disposal problems in the training programs for retail dealers, farm managers, and store keepers by rationalizing ordering of stocks based on the cropping patterns of the area and on a seasonal basis and issuing on a first in, first out basis; and
  - training for authorized officers in selecting sites for disposal pits for burying unwanted pesticides.

- Incentives and instructions are issued to government farms, allowing use of outdated herbicides for weed control in nonagricultural lands such as areas around buildings, roadways and fence lines. Other pesticides are buried in disposal pits lined with lime and sawdust.

- Products in public sector outlets outside the Department of Agriculture are quantified with the assistance of authorized officers.

- Major formulating plants dispose of deteriorated pesticides and unwanted pesticides and decontaminate drums prior to issue for recycling in their privately owned incinerators. Other firms which do not have such facilities dispose of their empty steel drums by crushing and recycling them at the Steel Corporation. The feasibility of this method of disposal is under review.

Despite these measures, the major problem of disposing of unwanted technical and formulated material has not yet been solved. Authorities have agreed to explore the possibility of obtaining the required expertise to identify and prepare landfill sites for hazardous wastes. However, while landfill sites represent only an interim solution to the problem, authorities believe that the costs of installing and staffing an incinerator are beyond the resources of the country at this time.

Pesticide Disposal in Thailand

By **Boonchob Bhatraruji**
Director, Agricultural Regulations Division, Department of Agriculture

In Thailand, hazardous wastes, especially toxic substances and heavy metal pollutants discharged from factories, are becoming a problem of great concern. Although the country imports nearly 4,300 tons of technical grade pesticides and 16,100 tons of finished products annually, existing regulations deal with treatment of waste rather than disposal of hazardous waste.

The Poisonous Articles Act of 1967, amended in 1973, controls the manufacture, distribution, sale and use of all poisonous articles, of which pesticides are but a minor component. Under the Ministerial Regulation, promulgated in 1982, the Minister of Agriculture is authorized to announce in the Royal Government Gazette the methods of application, destruction of poisonous articles or disposal of the containers under which the permit holders and users must comply.

Recommendations to the pesticide industry and farmers for the disposal of pesticides and pesticide containers are as follows:

Pesticide industries must have an industrial pollution control system.

- Organic pesticides (except organic mercury, lead, cadmium, and arsenic compounds) should be disposed of according to the following procedures:
  - Incinerate in a pesticide incinerator at the specified temperature dwell time combination, or at such other lower temperature and related dwell time that will cause the complete destruction of the pesticide.
  - If appropriate incineration facilities are not available, the organic pesticide may be disposed of by burial in a specifically designated landfill.

- For many factories, the solid residues which often contain hazardous substances are disposed of without further proper treatment and many of them lack a proper final disposal landfill site.

operation for many pesticides that involves a minimum of adjustment to accommodate pesticide wastes as an alternate or supplementary fuel source.

For any disposal occurring away from the actual site of use, transport of the waste, of course, is an important consideration. Re-use of rinsates is one of the disposal techniques to be considered further both from the standpoint of container design (to ease removal) and development of application techniques themselves. The simplest operation may be to dilute the rinsate further with water or soil and to spread the dilution lightly over fields already treated or over idle agricultural land in the immediate area. Careful separation of wastes between types of pesticides, i.e. herbicides, fungicides, and insecticides may be critical to avoid crop injury or illegal residue. A variation of this technique employed in some sparsely populated areas of the world is referred to as "land farming". In

- The first industrial hazardous waste treatment center, a pilot project, will be situated on 10 ha (100,000 sq m) of land in the western suburb of Bangkok at Samea Dam, Bangkhuntien district.

- There are chemical methods and procedures which will degrade some pesticides to a form which is not hazardous to the environment. However, practical methods are not available for all groups of pesticides.

Empty or partly empty pesticide containers are often found on the farm. According to the Ministerial Regulation, recommendations for the farmers to dispose of the waste pesticide and pesticide containers on the farm are as follows:

- Disposal in the soil, by burial in a specifically designated landfill is allowed. If possible, before disposal, the container should be cleaned by washing with water; the water can later be put in the sprayer for spraying.

- Waste toxic substances must not be allowed in water resources.

- While paper or plastic containers can be burned in the normal farm incinerator or rubbish tip, this method is not recommended in general because it may cause damage to the environment.

Policies and Measures for Disposal

Steps to improve the disposal of waste pesticides and pesticide containers in Thailand include the following:

- improve the existing regulations to focus on the list of chemicals under control by the Poisonous Articles Act, and requirement of waste disposal;

- install disposal facilities for hazardous wastes and designate disposal landfill sites in the country, even at the farm level; and

- increase awareness of the dangers of pesticide wastes, and educate authorities, retailers, users, and farmers in the safe and efficient disposal of waste pesticides and pesticide containers.

this scenario, remote areas may be subject to light applications, not exceeding label rates. This practice can be highly controversial, of course, since the area actually being treated would not otherwise be exposed. There is no benefit from the pesticide use, and repeated application, over time, could lead to environmental contamination problems similar to those which might occur at other disposal sites.

Detoxification of small quantities of pesticides may become a useful disposal practice. Among techniques being developed are use of portable ultraviolet disposal units and destruction of organochlorines using an ethylene glycol catalyst.

Management, education and available technology are the keys to gaining control of, and maintaining, proper pesticide disposal with minimum adverse impact on people or the environment.

Pesticide Advertising

By **Brian B. Watts**
Consultant, Pesticide Regulatory Affairs, New Zealand

Article 11 of the International Code of Conduct on the Distribution and Use of Pesticides deals with advertising, directing most of the requirements of this Article to industry (see Box 4, p. 96).

Definition

Advertising is defined in the Code as "the promotion of the sale and use of pesticides by print and electronic media, signs, displays, gift, demonstration or word of mouth".

While it is clear from the provisions of the Code that the requirements on advertising are addressed towards industry, it is highly desirable that there be provision in any law dealing with the control of pesticides to enable the responsible authority to control advertising which may be misleading or inaccurate, and to take action where the pesticide advertised is not registered.[1]

While some countries require approval of every advertisement before it is used, others have the power to take action if the advertisement is, in the opinion of the responsible authority, misleading or inaccurate. In either case, the interpretation of advertising and advertising licenses is both time consuming and difficult. In those countries with a strong trade association, it is appropriate for industry to police itself by way of an Advertising Code which is based on the provisions of Article 11. In those countries where such a process is in operation there is generally a high standard of advertising.

Monitoring the Observance of Article 11

FAO Questionnaire. Responses to the FAO questionnaire which was sent to all member nations in 1986 indicated that advertising practices were a concern in most of the 115 countries which responded. Because of the way the questions were framed, the responses could not be quantified. Nevertheless, a majority of the respondents cited advertising of unsubstantiated claims as a concern, and noted that sales staff were not adequately trained. Although the timing and purpose of the questionnaire were to establish baseline data, the responses do indicate the need for improved advertising practices.

South Pacific Regional Environmental Programme (SPREP). The SPREP reported on a review conducted among 19 member countries of the South Pacific Commission. Although respondents indicated that advertising was not perceived to be a problem and registered few complaints as to advertising practices, the use of misleading advertising, confusing names, safety claims and guarantees as to performance does occur.

Nongovernment Organizations (NGOs). Worldwide surveys by the International Organization of Consumer Unions (IOCU) and the Pesticides Action Network (PAN), including surveys in countries in the Asian area, indicate serious noncompliance with the Code, not only in advertising practices but in other areas as well.[2]

1/ This is a recommendation in the FAO Guidelines for Legislation on the Control of Pesticides.

2/ NGOs are very active in the field of monitoring the observance of the Code and have recently published a resource book for trainers, The Pesticide Code Monitor, which is published by IOCU, P. O. Box 1045, 10830 Penang, Malaysia.

Box 4. **Article 11 of the Code of Conduct**

The contents of this Article are as follows:

11.1 Industry should ensure that:

11.1.1 all statements used in advertising are capable of technical substantiation;

11.1.2 advertisements do not contain any statement or visual presentation which, directly or by implication, omission, ambiguity or exaggerated claim, is likely to mislead the buyer, in particular with regard to the safety of the product, its nature, composition, or suitability for use, or official recognition or approval;

11.1.3 pesticides which are legally restricted to use by trained or registered operators are not publicly advertised through journals other than those catering for such operations, unless the restricted availability is clearly and prominently shown;

11.1.4 no firm or individual in any one country simultaneously markets different pesticide active ingredients or combinations of ingredients under a single distinguishing name;

11.1.5 advertising does not encourage uses other than those specified on the approved label;

11.1.6 promotional material does not include use recommendations at variance with those of the recognized research and advisory agencies;

11.1.7 advertisements do not misuse research results or quotations from technical and scientific literature; and scientific jargon and irrelevances are not used to make claims appear to have a scientific basis they do not possess;

11.1.8 claims as to safety, including statements such as "safe", "non-poisonous", "harmless", "non-toxic", are not made, with or without a qualifying phrase such as "when used as directed";

11.1.9 statements comparing the safety of different products are not made;

11.1.10 misleading statements are not made concerning the effectiveness of the product;

11.1.11 no guarantees or implied guarantees – e.g. "more profits with..", "guarantee high yields" – are given unless definite evidence to substantiate such claims is available;

11.1.12 advertisements do not contain any visual representation of potentially dangerous practices, such as mixing or application without sufficient protective clothing, use near food, or by use by or near children;

11.1.13 advertising or promotional material draws attention to the appropriate warning phrases and symbols as laid down in the labeling guidelines (13);

11.1.14 technical literature provides adequate information on correct practices, including the observance of recommended rates, frequency of applications, and safe pre-harvest intervals;

11.1.15 false or misleading comparisons with other pesticides are not made;

11.1.16 all staff involved in sales promotion are adequately trained and possess sufficient technical knowledge to present complete, accurate and valid information on the products sold;

11.1.17 advertisements encourage purchasers and users to read the labels carefully, or have the label read to them if they cannot read.

11.2 International organizations and public-sector groups should call attention to departures from this Article.

11.3 Governments are encouraged to work with manufacturers to take advantage of their marketing skills and infrastructure, in order to provide public-service advertising regarding the safe and effective use of pesticides. This advertising should focus on such factors as proper maintenance and use of equipment, special precautions for children and pregnant women, the danger of reusing containers, and the importance of following label directions.

Implementation of Article 11

The importance of compliance with Article 11 as well as with other provisions of the Code of Conduct cannot be overstated. Advertisements are a powerful medium and misrepresentation could lead to disastrous consequences. Accordingly, legislation giving the authorities power to take action against misleading or inaccurate advertisements, against advertisements for nonregistered products, and/or against advertisements which are not in compliance with the Code, is essential.

In its efforts to assist industry to comply with the Code, GIFAP has issued a "Checklist on Advertising and Promotion" as part of its series "A Guide to the Implementation for the Agrochemicals Industry". As the Code's rules apply to promotional activities of all kinds, the Checklist covers product information and safety aspects as well as education and training (see Box 5 below).

Box 5. **Checklist on Advertising and Promotion**

Product Information

- Do you ensure that advertising does not contain any statement or visual presentation which directly or by implication, omission, ambiguity or exaggerated claim is likely to mislead the buyer – in particular concerning a product's nature, composition, suitability for use, efficacy, safety and official approval? (11.1.2, 11.1.10)
- Do you ensure that all statements in advertising can be substantiated technically? (11.1.11)
- Do you ensure that research results and scientific information are not misused in advertising and that scientific jargon is not used to give claims a spurious scientific basis? (11.1.7)
- Do you ensure that any guarantee contained in advertising – such as claims of higher yields or more profits – can be substantiated by technical evidence? (11.1.11)
- Do you ensure that advertising does not contain false or misleading comparisons with other pesticides? (11.1.15)
- Do you ensure that all advertising refers only to recommendations for use which are approved officially and appear on appropriate labels? (11.1.5, 11.1.6)
- Do you ensure that all technical product literature provides adequate information on correct practices – including appropriate safety precautions, recommended rates and frequency of application, safety to crops and safe pre-harvest intervals? (11.1.14)
- Do you ensure that in any one country you do not market simultaneously different pesticide active ingredients or combinations of ingredients with the same brand name? (11.1.4) However, suffixes to brand names such as "Extra" or "Plus" may be used to differentiate products.

Safety Aspects

- Do you ensure that advertising contains no claims about safety of products to humans or to the environment or to wildlife? (11.1.8) Expressions such as "safe", "non-poisonous", "harmless", "non-toxic", "low toxicity" etc. are **not permitted**, even with a phrase such as "when used as directed".

Box 5, Checklist, continued

Exceptions:

- Specific claims on the safety of a product to bees, beneficial insects etc., when it is used correctly, are permitted, provided scientific evidence is available to prove the claim.

- In technical literature intended for specialists rather than end-users, toxicological information may be displayed and discussed scientifically and conclusions about safety may be reached provided they are not misleading.

- Do you ensure that advertising contains no comparisons between the safety of different products? (11.1.9)

- Do you ensure that illustrations used in advertising do not depict potentially dangerous practices such as mixing and application without appropriate protective clothing, or use near food or use by or near children? (11.1.12)

- Do you ensure that in countries where some pesticides are legally restricted to use by trained or registered operators advertisements for them clearly and prominently draw attention to this restricted availability? (11.1.3)

Education and Training

- Do you ensure that all your advertising and product literature prominently displays a statement such as "Always read the label before using the product"? (11.1.13, 11.1.17)

- Do you ensure that all staff involved in promotion and sales are adequately trained and possess the necessary technical knowledge to be able to present complete and accurate product information? (11.1.16)

Control of Advertising in India

By **Manohar Lal Saini**
Secretary, Central Insecticides Board and Registration Committee, Ministry of Agriculture

There is no provision under the Insecticides Act, 1968 relating to the regulation of advertisements. Rather, advertisements are regulated in a general manner under separate legislation, "The Monopolies and Restrictive Trade Practices Act, 1969" (MRTP). The MRTP enforces the following restrictions on advertisements:

- false representation about the standard quality, grade, composition of the goods;
- false claims regarding sponsorship, approval, performance, characteristics, uses, benefits of the goods;
- false or misleading representation regarding need for, or the usefulness of, any goods;
- warranty or guaranty about performance, efficacy or length of life given to the public without sufficient basis; and
- giving false or misleading facts disparaging goods of other persons.

A specific proposal to incorporate the provision pertaining to the advertisement of pesticides under the pesticide legislation is being examined. The FAO Guidelines on the subject will be taken into account.

Control of Advertising in the Philippines

By **Nicholas R. Deen**
Officer-In-Charge, Pesticides, Fertilizer and Pesticide Authority

Legislation. The Fertilizer and Pesticide Authority (FPA) Rules and Regulations, Article V, Section 7 state that "Pesticides approved and registered by the Authority shall not be advertised in a manner that is false, misleading and deceptive, and not justified by the conditions of their registration".

In its subsequent guidelines, FPA prohibits the following practices:

- advertising a pesticide as "safe";
- showing inappropriate protective gear or showing pesticide application with bystanders present;
- including uses or other claims which are not on the approved label;
- promoting unregistered products in a manner implying they are registered;
- not stating restrictions on the use of a product in advertisements; and
- any false or misleading advertising.

Mechanisms of Control. Prior to the adoption of the FAO Code of Conduct, FPA, in recognition of its limited resources for effective control, established close coordination with the private sector in the monitoring of, and compliance with guidelines/policies regarding advertisements involving pesticides. Among the agencies/institutions with which FPA coordinates are the Philippine Board of Advertising (PBA); the Agricultural Pesticide Institute of the Philippines (APIP); and pesticide companies concerned.

Based on the belief that the industry can best be regulated and its interests best protected by the practitioners themselves, the above agencies organized themselves for the purpose of rationalizing the advertising industry, adhering to the tenants of the Code of Ethics for Advertising and Sales Promotions.

The industry does, however, consult with the FPA periodically before a radio broadcast or printed advertisement is aired or published. In addition, the FPA works closely with the PBA on all pesticide-related television or radio advertisements.

Philippine Board of Advertising. The PBA screens radio and television advertisements (both local and foreign), except local accounts (any product or service sold within a geographical province) for the purposes of (i) ensuring that the advertisement is in the consumer's interest; and (ii) ensuring truth in advertising. All members of PBA are voluntary subscribers.

The screening Board is composed of an advertising sector, a technical sector (e.g. FPA/APIP for pesticides, fertilizers and other agricultural chemicals) and a consumer sector. There is a fee for screening.

The PBA reserves the right to recall any advertisement; assesses a fine for noncompliance; and can order a company to withdraw an advertisement which does not adhere to PBA rules and regulations.

Control of Advertising in Indonesia

By **M. Satta Wigenasantana**
Director of Food Crop Protection/Chairman, Indonesia Pesticide Commission, Ministry of Agriculture

To ensure human and environmental safety and efficiency in the use of pesticides, the Government of Indonesia instituted the Pesticide Act of 1973 controlling the distribution, storage and use of pesticides. This Act requires pesticide producers or their local representatives intending to market their products in Indonesia to apply to the Minister of Agriculture for registration of their product. The Minister of Agriculture is assisted by an inter-ministerial advisory board, the Pesticides Committee, which is responsible for evaluating the data relevant to the products' efficacy and potential hazards.

All pesticides must be registered by the Minister of Agriculture prior to commercial distribution. The registration process is stipulated in an Agriculture Ministerial Decree whereby the purpose and manner of use of registered pesticides and their quality are specified to ensure their safe and effective use. This Decree also stipulates that producers concerned or their local representative, being the registration holder for their products, are responsible for pesticide quality, packaging and labeling. Requirements for packaging and labeling are stipulated in Ministerial Decree No. 429 of 1973. Proposed text for the label should be approved by the Pesticides Committee before printing.

The registration holder, as required by the Ministerial Decree on pesticide registration which is issued periodically, is responsible for the dissemination of information about the product. Such information must comply with the existing registration data and the provisions of the Decree pertaining to the safety and efficacy of representative pesticides. Pesticide registration holders intending to disseminate information about their products to the general public must submit the proposed draft and layout of the information to the Pesticide Committee for approval.

Advertising as a means of communicating a particular message about the pesticide to the user is similarly controlled by the Ministerial Decree covering registration. In addition, provisions under Article 11 of the Code of Conduct have been adopted by the Pesticides Committee to control pesticide advertising.

Control of Pesticide Imports

By **Brian B. Watts**
Consultant, Pesticide Regulatory Affairs

Every country wishing to control the type and use of pesticides must also have the ability to control the entry of pesticides into the country. Many countries exercise this control by allowing only registered pesticides to be imported, sold or offered for sale or use. Other countries require that a permit to import be issued by the registration authority, or some other body. The FAO Guidelines on Legislation for the Control of Pesticides recommend that legislation should provide the means for import control – by stating that no importation of pesticides will be allowed without an appropriate permit from the responsible authority – and that all countries should develop the infrastructure necessary to implement this control. The authority responsible for registration should coordinate with the customs agency in the exercise of this requirement, and must keep customs fully and clearly informed on which pesticides are registered. The latter information should be trade name/importer or supplier specific, and the lists must be updated regularly.

Examples of Import Control

The Solomon Islands has had a registration scheme in operation since 1982 which includes the requirement that "no person shall import any pesticide unless it is registered under these regulations". However, to implement this requirement fully, the customs agency must first be given a short-term administrative order, and then a longer-term Gazette Notice, which makes the pesticide a restricted import.

Papua New Guinea has a requirement in its Environmental Contaminants Act, under which regulations to "register" pesticides have been promulgated, that "no person shall import, sell, manufacture or distribute a hazardous environmental contaminant without being the holder of a permit for such importation, sale, manufacture or distribution". The responsible authority conducts an evaluation, which is analogous to registration, to decide whether or not to issue a permit to import. Pesticides, by being declared to be environmental contaminants, are thus controlled at the point of entry. As the scheme is in its beginning stages, only two permits to import have been issued, although more are imminent. The final stage, which is about to be taken, is to make pesticides a prohibited import under customs legislation.

The Cook Islands Pesticides Act, the implementation of which is imminent, states in Section 10 that "no person shall import any pesticide into the Cook Islands unless it has been registered pursuant to the provisions of this Act". The same Act places a requirement on the customs agency: "It shall be the duty of every Customs officer to assist in the enforcement of Section 10, and to prevent the importation into the Cook Islands of any pesticide where such importation is contrary to the provisions of this Act, and for such purposes shall exercise all the powers conferred on Customs Officers by the Customs Act 1913 in the case of uncustomed or prohibited goods".

Until recently the Pesticides Act in New Zealand did not deal with imports specifically and contained only the requirement that no person shall sell any pesticide unless it is registered. However, recent increases in imports for own use has necessitated stricter controls. Control is now exercised under a system which requires that imports are not for sale.

Conclusion

It is difficult to control entry across most borders, a problem which is heightened in land-locked countries with long and sometimes uncertain borders or in those countries with long coastlines. In most cases, total import control is not possible. However, every effort and as much resource as possible must be devoted to controlling entry. The consequences of no import control could be disastrous.

Control of Imports in Bhutan

By N. K. Pradhan
Plant Protection Services, Agriculture Department

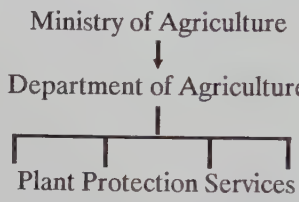
All pesticides used in Bhutan are imported, mostly from India although a few come from other sources.

Bhutan's dependence on imported pesticides is expected to continue as it is not economically feasible for the country to establish its own formulation plants for the variety of pesticides used. Also, due to the close proximity to India and the similarity between the pests and diseases controlled, the almost exclusive dependence on imports from India is expected to continue.

Prior to 1984, more than 50 different types of insecticides were being used in the country, apart from fungicides, rodenticides and weedicides. Further, each of the 18 district agriculture officers was responsible for the procurement of pesticides for his district. Pesticides were often used indiscriminately. However, in 1984 the Plant Protection Project began operations under funding from the European Community.

Pesticides classified as extremely and highly hazardous in the WHO Recommended Classification of Pesticides by Hazard were phased out of use in Bhutan, and, although one or two pesticides in the Ib category are still used as no substitutes have been found, the number of insecticides used now is less than fifteen. The country is working toward effective control of its pest and disease problems.

The Plant Protection Division is organized as follows:



While one individual is responsible for carrying out plant protection activities in each District, the head of Plant Protection Services is the only person responsible for the import and distribution of pesticides. This centralized procurement system gives the country more control over the selection and purchase of pesticides.

The following procedures are implemented for the procurement of pesticides in Bhutan:

- indent from district agriculture officers and Agriculture set-ups is compiled;
- advertisement for tender is made in the National Weekly;
- tender document is opened and evaluated;
- letter of contract for supply is awarded;
- receipt of supply and transportation to various Districts, Headquarters is made; and
- pesticides are distributed to farmers.

Certain problems in procurement are experienced. For example, many dealers representing a variety of companies respond to the advertisement for quotations. Prices for the same product often vary widely from one company to the next and the procurement office must choose the lowest bid. As the country does not have a testing facility, the product cannot be tested for quality prior to acceptance. Therefore, assistance in testing pesticides prior to import is needed.

A new system for meeting the pesticide requirements for 1989 is being implemented – i.e. the name of a manufacturing company, chosen on the basis of literature from Indian universities having performed trials with products from that company, was specified against each product. Quotations from dealers other than those specified for a particular product were rejected. The success of this approach, however, has not yet been tested.

Control of Imports in Malaysia

By **Zainal Abdul Rasol**
Crop Protection Branch, Department of Agriculture

Malaysia's Pesticides Act was passed in 1974, although various regulations under the Act for the safe, effective and efficient use of pesticides have since been incorporated.

Measures currently enforced include:

- control of importation, manufacture, formulation, packing and repacking of pesticides by registration rules;
- control of pesticide labeling;
- control of importation of unregistered pesticides for educational or research purposes; and
- licensing of premises where pesticides are sold or stored for sale.

The function of the Pesticides Board is primarily to ensure that the Act is implemented.

Control of Import Through Registration

The Act requires that all pesticides in the country, whether imported or manufactured, be registered with the Pesticides Board. Unregistered pesticides may only be imported for educational or research purposes by means of a permit.

Only locally registered companies may apply for registration of their products. Applications for registration must be made on specific forms available from the Department of Agriculture. Eight copies of the application form, which incorporates supporting data and information in the form of appendices, must be submitted to the Board together with a sample of the product and eight copies of the proposed label.

The label must include warning or caution advice sufficient to prevent risk to humans or animals, the name of the pesticide and its recommended uses.

All pesticides, whether imported or manufactured locally, must meet the same requirements before they can be registered. In addition, they must be properly labeled prior to their sale.

All registered pesticides are identified by their Board-assigned registration number. Registrations are valid for three years from the date of registration, unless otherwise terminated, suspended or cancelled. There is a fee for registration and/or re-registration. On registration the applicant is given a "certificate of registration".

Control of Imports Through Import Permit

Persons requesting permission to import a pesticide for educational or research purposes must apply for a permit to import. Applications are submitted to the Pesticides Board in duplicate, with separate applications made for different consignments of pesticides. If several or different pesticides are to be imported in a single consignment, a single application and a fee for a permit must be submitted together with the application. Permits to import are valid for not more than six months. A permit authorizes the importation of one consignment only for one or more pesticides within a specified period.

Malaysia (continued)

Enforcement

Custom Prohibition Order. Importers of pesticides are required to observe the rules and regulations stipulated under the Customs (Prohibition of Imports) Order 1987.

The import license granted under this Order and the original permit or a certified copy of the registration certificate must be delivered by the importer to the appropriate customs office. A product is allowed into the country if it is accompanied by a valid registration certificate or import permit, and after customs has ensured that the name of the importer and name of the registrant or permit holder are in accord and that the import is the same chemical that has been approved. If the consignment does not comply with the approval, the product is confiscated by the customs authority.

Pesticides Enforcement Unit. This Unit monitors godowns, stores and shops to oversee the implementation of the rules for compliance with the provisions of the Act. If unregistered pesticides are found, the merchandise is confiscated and the offender is prosecuted in court.

Control of Imports in Thailand

By **Boonchob Bhatraruji**
Director, Agriculture Regulatory Division, Department of Agriculture

According to the Poisonous Articles Act of 1967, no ordinary or highly poisonous article (or the three categories of pesticides expressed by WHO) shall be brought in personally or imported unless a permit has been obtained from an authorized official. Highly poisonous substances may be imported only via designated and specified customs stations as promulgated in the Royal Government Gazette. Person having permit to import poisonous articles must provide to the authorities the chemical and trade names of the active ingredients, the scientific names of inert ingredients, quantity or ratio of active ingredients contained in any article, the particulars on the poisonous article containers, method of packing, wrapping or binding of such containers, their place of manufacturing or storage and other information regarding the poisonous articles imported in compliance with principles of the Ministerial Regulation.

Persons who import poisonous article(s) into Thailand must inform the officials concerned three days before the shipment arrives, giving the name of the importer, the name of the transporter and the name of the customs station.

The method of shipment must follow the recommendation of the 1982 Ministerial Regulation, i.e. the poisonous article must be delivered by the specified transportation; and must be packed in a container or package with the skull-and-crossbones sign, and be labeled with the words "Poisonous Article".

Permits issued in accordance with this Act are valid within one year from the date of issue. Renewals are available but application for renewal must be made prior to permit expiration, whereupon transactions may be carried out unless otherwise forbidden by the authorities. In the event a permit is lost or destroyed by natural causes, application for replacement must be made within fifteen days after the loss or destruction has been noted.

Control of Imports in Myanmar

By **U Maung Maung Tin**
Deputy General Manager, Plant Production, Ministry of Agriculture and Forestry

Technical-grade pesticides are neither manufactured nor formulated in Myanmar. All pesticides used in the country are imported as formulated products. However, the Ministry of Industry I established a pilot formulation plant in 1988 with assistance from the United Nations Industrial Development Organization (UNIDO) and local formulation is expected to begin in late 1989. Therefore, most of the future imports are likely to be technical grade pesticides.

Controls Implemented Prior to Import

Control practices for candidate pesticides and recommended pesticides (commercially used pesticides) prior to import are described below:

Candidate Pesticides. Candidate pesticides intended for commercial use are evaluated by the Plant Protection Service on (i) effectiveness on target pests and superiority to the existing compound; (ii) phytotoxicity; (iii) residues in crops; and (iv) toxicity (hazard class as specified by WHO/FAO). The experimental period lasts two to three years before being recommended for commercial use.

Recommended Pesticides. Recommended pesticides are those which are already in commercial use in the country. Specifications are based on FAO Guidelines and are issued to the intended suppliers, who are asked to submit samples before import contracts are granted. These samples are evaluated for the following qualities:

- per cent of a.i content, conformity to the specified value;
- emulsion quality, suspension quality and soluble quality;
- quality of containers; and
- labels and instructions.

Post-Import Control

A recommended pesticide which is in commercial use may be withdrawn from further recommendations if new information is received either from within or outside the country which indicates that the pesticide is harmful to users, crops or the environment.

Pesticide Law

Myanmar has no legislation regulating the use of pesticides, and the need for legislative control was not seen as acute because of the "monopoly" position of the Government in the pesticide industry. However, with the recent liberalization of the country's economic policy, and the expected privatization of the pesticide industry, a Pesticide Law is being drafted on the basis of various FAO Guidelines. The law is under review and, when enacted, pesticide imports will be governed by a registration scheme.

Module D: Regulatory Decision Making

Alternative Decision Rules

By **Edwin L. Johnson**
Director, Developing Countries Staff, Office of International Activities, US EPA

To reach regulatory decisions, the regulator must combine both scientific concepts and policy options through a decision rule which integrates all these factors. The decision rule states the objective by which the regulator determines the optimum regulatory position. The decision rule adopted by an individual country will determine how the regulator makes decisions about the safety and acceptability of a pesticide for a specific purpose and the data and information required to make that decision. The scientific evaluation of a particular set of data or a study may be exactly the same under various decision rules but the scope and complexity of the analysis may differ substantially and the ultimate conclusion will most certainly be different for each decision rule.

The major decision rules are discussed below in the order of increasing data requirements and complexity. A combination or extrapolation of these is also possible.

Description of Alternative Decision Rules

No Adverse Effect. The simplest decision rule is not to permit the use of any pesticide if it produces any adverse effect in test species or in humans. A major example of this approach in the US is the Delaney Clause of the Federal Food, Drug and Cosmetic Act (FFDCA). The Delaney Clause prohibits the establishment of a food additive tolerance at any level for a pesticide shown to be oncogenic in humans or test animals. The rule is absolute, requiring only a yes or no answer. It does not distinguish between degrees of potency, allow for balancing of risk and benefits, nor permit comparison of risks among previously approved old pesticides and new pesticides of lesser risk.

Such a decision rule may have the perverse effect of continuing the use of an older, more hazardous compound and prohibiting or limiting the use of a newer, less risky compound thus depriving society of safer and potentially more effective alternatives. The older compound may have passed the "yes-or-no" test because of the prevailing scientific methods for evaluation. The more sensitive test methods and closer scrutiny of compounds by regulatory agencies in use now may mean that newer compounds fail the test even though they may be less risky than currently approved pesticides for the same uses.

Also the use of the pesticide may be indicated on raw agricultural commodities under the risk/benefit approach used under the US Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) to regulate registration and raw commodity tolerances, but its use precluded because of residues in processed foods resulting from that same use. Different decision rules applied to the same pesticide for registration and MRL purposes can create serious contradictions, indicating that whichever decision rules are applied, they be applied consistently.

The National Academy of Sciences conducted an analysis of the environmental and economic costs and benefits of the Delaney Clause. The study concluded that "pesticide residues in food, whether marketed in raw or processed form or governed by old or new tolerances, should be regulated on the basis of consistent standards. Current law and regulations governing residues in raw and processed food are inconsistent with this goal". The study recommended the implementation of a more consistent and simplified regulatory approach which treats raw and processed foods alike.

The only data requirements needed to implement this approach would be animal studies showing whether a particular effect can be induced regardless of dose or exposure at which the effect occurred.

No Significant Adverse Effects in Humans. The simple "yes or no" decision rule can be modified to prohibit the use of only those pesticides which produce

significant adverse effects. The application of this rule would require the use of dose-response animal studies and definition of significant adverse effects. Use of pesticides which produce adverse effects exceeding the defined risk thresholds would not be allowed. This decision rule would permit regulators to distinguish between degrees of potency associated with various pesticides. The principal difficulty with such an approach is the requirement to define "significant" and "adverse".

Risks Acceptable Up to Benefits of the Same Type. Under this decision rule, any type of risk may be accepted only if commensurate types of benefits would accrue from the use of the pesticides. For example, risks to humans from food residues would be acceptable only to the extent that they are offset by the same kind of benefits to humans. Health risks would be accepted only to the extent that the use of the pesticide generates commensurate health benefits. This approach is still risk-based, but requires additional information on exposure as compared to the above approaches, as well as information on the health benefits obtained. Examples include pesticides which reduce the levels of aflatoxin on foods or the growth of pathogenic organisms in foods.

Risks Acceptable up to Aggregate Benefits. This decision rule is the one used in the US in regulating pesticides. An evaluation of all risks to humans and the environment is made and these are traded against total benefits of the use. This approach assumes that: (i) risks and benefits may be compared even though they are not stated in commensurable units; (ii) a weighting system can be developed that reflects social values placed on agricultural benefits and various kinds of human risk; and (iii) issues of equity, such as who receives the benefits and who bears the risks, can be accommodated. The data requirements for this approach are significant, requiring the full panoply of toxicology, exposure and residue chemistry data as well as benefits information. This approach considers risks and benefits to food consumers, applicators, farmers, farm workers, the general public and the environment.

There must also be some feedback of public values if the regulator is to be responsive to real social judgments about the relative value of, and the distribution of such risks and benefits. The US Congress has several times provided such feedback. Congress has played a strong role in determining the balance between risk and benefits of various kinds and their socially accepted distributions. This kind of check and balance is necessary for equitable application of this decision rule because of the many subjective factors involved.

Benefit Exceeds Cost. This approach differs from the one above in that it attempts to put all risks and benefits into common numeric measure that compares monetary costs of pesticide use against all monetary benefits of its use. Difficulties associated with the previous approach remain, particularly in the value judgments related to each kind of risk and benefit. This approach assumes that certain kinds of risk can be measured in dollar terms. It resolves none of the equity issues. It is usually very controversial with both regulatory officials and public interest groups and, to the knowledge of the author, has never been applied to any real-life pesticide regulatory situation.

Conclusion

Since most all pesticides pose some potential risk to humans or the environment, decision rules which tend toward zero risk are impractical. Absolute measures of acceptable risk do not accommodate common sense notions that risks should in some fashion be commensurate with benefits received for taking that risk.

Cost/benefit analysis remedies many of the deficiencies of simple decision rules but is difficult to apply. Many risks cannot be quantified in economic terms and many benefits are not readily measurable in quantified monetary terms. This often results in excessive weight being given to those economic values easily measured in monetary terms.

It can be concluded that a risk/benefit decision rule strikes an appropriate balance between these strengths and weaknesses of alternative decision rules and is the rule most applicable to pesticide regulatory decisions.

Benefits Assessment

By **Edwin L. Johnson**
Director, Developing Countries Staff, Office of International Activities, US EPA

Pesticides are by their nature intended to be toxic to some form of living organism. The previous paper dealt with risks posed by pesticides and their assessment. It seems clear that society should not be asked to accept such risks without gaining offsetting benefits.

This paper discusses the types of benefits that might be considered, suggests ways of evaluating them and presents the concept of alternative cost as a limiting factor in benefits assessment. The impact of efficacy, problems of resistance and the role of integrated pest management strategies are discussed.

Discussion of Benefits

Benefits, simply stated, are the economic and intangible goods that are provided by the use of a pesticide. In the case of agrochemicals, these are usually increased yields and/or reduced costs of production. In the case of public health pesticides, these are measured in terms of reduction of diseases.

Specifically, benefits to consider in evaluating a pesticide include:

- increased crop yields;
- decreased production costs;
- viability of subsistence farmers;
- ability to export;
- food prices to consumers;
- reduction of stored crop losses;
- increased aesthetic enjoyment of the environment due to fewer pests; and
- reduction in disease through vector control.

The income and employment generated by the production and distribution of a pesticide might be cited as a benefit, but it is usually not considered as such. Since alternative pest control measures will likely be implemented there are some substitutions. However, a developing country might wish to consider the benefit of local production or formulation of a pesticide to the national economy in assessing its benefit as compared to an alternative which might, for example, need to be imported.

The Role of Alternatives

The maximum benefits attributable to a pesticide are limited to the cost of alternatives. One cannot assume that the value of a crop, for example, is completely lost if a particular pesticide is banned. There are usually alternatives available which provide a comparable or possibly somewhat reduced level of production. Therefore, the benefit is limited to the increased costs of production plus net crop losses accruing with use of the alternative. Usually, the production costs are minimized, at least in theory, with the use of the pesticide under review to maximize profit for the farmer. In reality, habit, tradition, sales promotion and a number of other factors may, in fact, result in farmers using pesticides that are not the most economical input; they can actually increase yields or reduce costs through the use of alternatives if the particular pesticide were to be banned. This is a result contrary to common expectation and traditional economic theory, but the regulator should not be surprised if this case appears periodically.

Integrated Pest Management

Alternatives to be considered in assessing benefits should not be limited to other pesticides. Advances in IPM techniques may often lead to effective, efficient pest management practices. These should be considered by regulators in preparing a benefits assessment. Costs of training and education in IPM may have to be considered in evaluating the costs of this option as well as phase out options which permit time to accomplish the changeover.

Measuring Benefits

The exercise of assessing the benefits of a particular pesticide involves a comparison of the aggregate economic yield to farmers with continued use of the pesticide with their economic yield under alternative crop production programs in the absence of the pesticide. Scenarios must be developed which include:

- continued production of the same crop with alternative pest controls;
- changes in cropping practices including new varieties or different crops;
- more extensive production; and
- discontinuing production of the crop.

The difference in economic return to the farmer between current production practices and the scenario which gives the least loss of income is the benefit of continuing use of the pesticide under consideration. (Alternatively stated, the loss expected, or the cost of the alternative scenario most likely to be pursued in the absence of the subject pesticide is the benefit to retaining its use.)

This analysis must be done for each crop on which the pesticide is used, because regulatory options include banning a pesticide only on selected uses.

Another aspect of benefit analysis involves possible differential economic impact on different classes of farmers. For example, small, or marginal producers may be forced out of business under some alternative scenarios while larger, more efficient farmers will stay in business. Therefore, especially in a country concerned about retention of subsistence farmers, the distributional effects must be considered along with the social costs of forcing farmers off the land.

Often information on alternative control practices and the impact on farm income and yields may be available from experience in other countries. However, most of this information must be derived locally.

Benefits and risks are used in only a relative sense in risk/benefit analysis, i.e. one looks at the difference between the status quo and an alternative situation resulting from a proposed regulatory action and determines the net change in position. Therefore, absolute measures of benefits are considerably less important than relative measures. This means that one can talk of prices of food doubling, or one-fourth of the producers of a crop being forced off the land, or a minor increase in cost, for example, and still be able to use this information in a decision analysis.

In the case of the public health benefits, the evaluation is more direct. What are the potential health effects with and without the pesticide? Expected cases of the disease with and without the pesticide are an appropriate measure.

Aesthetic values are much more difficult to measure. For example, mosquito vector control provides a health benefit, but it also provides the freedom from annoyance by these pests. Control of rats has a public health benefit, but it also makes life more comfortable. These benefits can usually not be evaluated in a quantitative way and can merely be described as a plus or minus in the evaluation. Economists have tried various measures of willingness-to-pay, the usual measure of value, for such benefits, but these often suffer from the "free-rider" problem.

There may also be a loss to the economy if the pesticide to be banned is produced locally and the alternative is imported. The persons and the plant engaged in production may not be suitable for production of other chemicals or readily absorbed into other activities.

There are several texts on benefits assessment, and as benefits assessment is also basic economic alternative cost evaluation applied to the case of a pesticide, generic references in economics are also relevant. Most countries have economists available to assist in such assessment with the technical input of agricultural and marketing experts.

Balancing Risks Against Benefits

By **Edwin L. Johnson**
Director, Developing Countries Staff, Office of International Activities, US EPA

The final step in making a risk/benefit decision on the use of a pesticide involves the comparison of risks and benefits to reach a regulatory solution which results in risks consistent with reduction in benefits. This procedure is not a simple, mechanical one. It involves the comparison and tradeoff of values, some of which are quantitative and some qualitative, and values assessed in different terms of measurement, some in monetary terms and some in probabilities of occurrence of a health or environmental risk.

Reaching a decision requires the application of social, economic and political priorities in weighing the relative importance of a reduction in risk against the loss of benefits. For these reasons, the process must be a socio-political rather than a strictly technical one. Also, because it involves social value judgments, individuals may reach different final judgments on the appropriate regulatory action, even if they agree on the basic data used in the decision.

This decision-making process can benefit from the input from many sources including industry, growers and public interest groups. Their input with respect to various possible alternative regulatory decisions can help to sharpen the basic data on risks and benefits and, more importantly, can assist in defining the outer limits on social value judgments. In the end, however, it is the regulator that must apply the appropriate value judgments taking into account broad policy goals of the government.

This paper discusses approaches to making a risk/benefit decision using a decision matrix. It also illustrates how different national policy goals may lead to different decisions even with the same input data.

While the paper can describe the steps in the process, it cannot define the complete set of policy goals that must be considered in the individual countries.

Problems in the Application of Risk/Benefit Decision Making

Several difficulties are raised in the application of risk/benefit decision making. The most common of these are:

- too many alternatives, making it unmanageable;
- noncommensurable values for the various benefits, human health and environmental measures involved; and
- imprecise measures of the social values or weights to be placed on economic, health and environmental effects of alternative decisions.

The question of alternatives has been briefly considered in the discussion of benefits assessment, where it was pointed out that there are usually a finite number of practical, enforceable options for a regulator to consider even though there are a great many hypothetical ones. The task is to screen out the impractical alternatives, and those which are minor variations on a major alternative.

Once a broad decision is made, the major option can be refined. For example, a choice can be made between banning and retaining the use of a pesticide. If the basic choice is to ban its use, an incremental decision could be whether to make the ban effective immediately, effective after the use of existing stocks or effective after sufficient time for the development and dissemination to farmers of alternative pest control approaches or training in safe use of more acutely toxic alternatives.

The difficulty of comparing alternatives yielding different and noncommensurable benefits and costs can be avoided partially by using a paired comparison of alternatives as discussed below, although nothing can resolve this basic dilemma completely. Each comparable attribute of an alternative can be compared to each alternative, one at a time, and a decision made as to which alternative is preferred. Where one alternative is preferable in all respects, i.e. if it imposes the least alternative cost on farmers, reduces all health and environmental risks from the status quo and all other alternatives, then the choice is easy. In the more usual case, however, the regulator is not so fortunate. An alternative to the status quo will have a production cost increase, decrease one health effect but increase another, or increase an environmental effect compared to other alternatives. The choice here is more ambiguous, necessitating the application of value judgments as to which is most acceptable. For example, if the two factors being considered are economic cost of a ban and the reduced cancer-causing effect, the choices will be different depending upon the relative weight placed by that society on economic effects versus cancer effects.

If the variable of increased chance of accidental poisoning because of the acute toxicity of the alternative pesticide is introduced, the choice is even less clear. Someone must decide if the potential increase in occupational poisonings is warranted by the reduction in cancer risk, all other things being equal. Or this might lead to a reformulation of the alternative to include mounting a program of education and training, protective equipment requirements and restriction of use that could reduce the potential of acute poisoning but at some higher cost.

The relative weight put upon various consequences of alternatives is not clear cut. The regulator must depend upon his own assessment of such weights, on political guidance, use of advisory groups or legal intervention. If the regulator uses his own weights, a quicker decision, but one which is less likely to receive a consensus endorsement by all interested parties, can be made. Sometimes legislative bodies provide guidance in hearing records or legislative history. Advisory groups of persons having knowledge and representing a range of social points of view can provide a range of possible weights and even in some instances converge on a generally acceptable solution.

The pesticides committee recommended by FAO Registration Guidelines is another mechanism, as is a panel composed of outside private sector experts.

Feedback on potential alternative regulatory decisions is a very important input to decision making that can be provided by public interest groups, growers' associations and farmers, academics and industry. Such input can be formalized through advisory panels, Delphi procedures, or by informal, ad hoc meetings or "leaking" of likely decisions to the media to obtain reactions. On balance it is probably better to structure the decision advisory procedure somewhat, to maintain a modicum of order.

Defining the Decision Matrix

Theoretically, there can be an infinite number of regulatory responses to a potential risk posed by a pesticide. Fortunately for regulatory practitioners, there is almost always a finite number of actions that can realistically be undertaken and enforced. Among these are:

- no action, or allowing the current use of the pesticide to continue;
- restrict use in some manner, e.g. through reduced application rates, modified timing of applications, reduced numbers of applications, use only by certain classes of applicators, or increase PHI to reduce residues;
- prohibit one or more uses of the pesticide; and/or
- ban all uses of the pesticide.

Table 10 shows the outline for a simplified risk-benefit decision matrix, or tabular presentation for the risk and benefit information. The rows indicate alternative regulatory options; the columns provide various indicators of risk and benefit. The example is simply illustrative. An actual matrix may well have considerably more rows and columns to accommodate actual conditions of interest to the regulator.

Table 11 shows the same matrix with data filled in for a simplified example. The data shown are fictitious but would normally come from the analyses of risks and benefits described previously.

Table 10. Decision Matrix Format

Alternative Controls	Risks			Benefits		
	Human					
	Food	Applicator	Environmental	Crop Production	Exports	General Economy
A. Continue Current Uses						
B. Restrict Use (Spec. Equip.)						
C. Ban Major Uses; Retain Special Uses						
D. Ban All Uses						

Table 11. Decision Matrix Filled Out

Alternative Controls	Risks			Benefits		
	Human					
	Food	Applicator	Environmental	Crop Production	Exports	General Economy
A. Continue Current Uses	Cancer 10-4	Cancer 10-3 Acute Low	Food chain bioaccumulation	Costs = 10 Production = 100	Required for mangoes	Formulation local; 20 employees
B. Restrict Use (Spec. Equip.)	Cancer 10-4	Cancer 10-4 Acute Low	No change	Costs = 12 Production = 100	No change	No change
C. Ban Major Uses; Retain Special Uses	Cancer 10-6	Cancer 10-5 Acute High w/alternatives	Reduce Bio-accumulation Increase avian mortality	Costs = 15 Production = 80	No change	Loss of Production
D. Ban All Uses	Cancer 0	Cancer 0 Acute High	No bioaccumulation Further increase avian mortality	Costs = 20 Production = 75	Reduced exports; 5 units	Plant closure; 10 % reduction in marginal farmers

Comparisons can be made of the incremental risk reductions and associated incremental costs (reduction in benefits) in moving down the matrix to increasingly restrictive regulatory actions.

Alternatively, decisions can be approached more systematically by using a process of paired comparisons as illustrated in Table 12. Each alternative regulatory action is compared one at a time with each of the other alternatives. The preferred alternative is assigned a score of one; the other of the pair, a score of zero. In the case of indifference, each receives a score of 0.5. The alternative receiving the highest total score is the preferred option. For example in Table 12a, Option D would be selected.

Tables 12a and 12b illustrate the impact of the differing social priorities or value judgments on the selection of regulatory action.

If the social values weigh heavily on risk reduction, then a regulatory decision to ban all uses might be selected. The loss of production and exports of minor crops would have to be absorbed by the economy and perhaps even be made up by imports of some commodities. The decision might tend to be made in a society that is relatively wealthy, in which agricultural production and exports account for a relatively small part of total exports, foreign credits and national product and in which food supplies generally are adequate or even in surplus. This situation is represented in the preferences displayed in Table 12b.

Another example is an alternative decision in a country that depends heavily on export of special crops for foreign credits and its contribution to national product. This country may have a barely adequate food supply and seek to minimize production reductions and increased food costs. It might be decided that in the overall scheme of things, it cannot afford to ban all uses. This country might well make a different decision from the one in the former case and simply restrict application to reduce applicator risks.

Of course, for export crops the decision must take account of the requirements of importing countries to ensure that they will still be accepted. If the food importing country has banned the pesticide for use on domestically produced crops and has revoked approval for residues on imported foods for that pesticide, then clearly the exporting country must take that into account. If exports are a major source of foreign credit and export growth is a national economic policy goal, then acceptance of the pesticides used on foods exported must meet the requirements of the importing country.

Table 12. Example of Paired Comparison

a. High Social Priority on Cancer Reduction

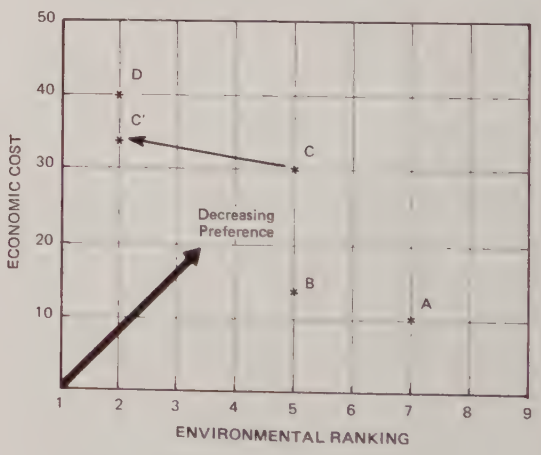
Compare Alternative	With Alternative A	B	C	D	Sum
A	-	0	0	0	0
B	1	-	0	0	1
C	1	1	-	0	2
D	1	1	1	-	3

b. High Social Priority on Food Production and Exports

Compare Alternative	With Alternative A	B	C	D	Sum
A	-	0	0	0	0
B	1	-	1	1	3
C	1	0	-	1	2
D	1	0	0	-	1

Figure 5 illustrates a graphical means of comparing alternatives. A subjective environmental ranking is plotted against the costs for each alternative, with a higher rank being assigned to less desirable environmental situations. Once again a choice will need to be made between economic costs and environmental factors as illustrated by Alternatives B and D.

The arrow between Alternatives C and C' shows how an alternative's ranking can be improved, in this case by assuming measures are taken to reduce potential acute effects at little additional cost.



Note: Environmental ranking — Lower numbers indicate more desirable outcomes.

Figure 5. Graphical Approach to Comparing Alternatives

Prior Informed Consent: The Decision Documents

By **Brian B. Watts**
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This paper outlines the proposed changes to Articles 2 and 9 of the International Code of Conduct on the Distribution and Use of Pesticides. These changes will be placed before the FAO Conference in November 1989 for approval, thereby implementing the decision taken at the 1987 Conference that "the principle of Prior Informed Consent be included in the Code of Conduct in the next biennium". The Guidelines which were developed to operate the PIC process and which are also to be considered by the Conference, are also discussed below. Decision Guidance Documents which will be a useful aid in providing background information for countries to arrive at a position on PIC are being developed; a draft outline is shown on p.123.

Proposed Amendments to Article 2

The following two definitions were proposed to be added to Article 2:

"Prior Informed Consent" (PIC) refers to the principle that international shipment of a pesticide that is banned or severely restricted in order to protect human health or the environment should not proceed without the agreement, where such agreement exists, or contrary to the decision of the designated national authority in the participating importing country."

"Prior Informed Consent Procedure" (PIC Procedure) means the procedure for formally obtaining and disseminating the decisions of importing countries as to whether they wish to receive future shipments of pesticides that have been banned or severely restricted."[1]

Proposed Amendments to Article 9

Proposed changes to Article 9 are indicated in italics.

9.1 The government *of any country that* takes action to ban or severely restrict the use or handling of a pesticide in order to protect health or the environment should notify *FAO, as soon as possible of the action it has taken. FAO will notify the designated national authorities in other countries of the action of the notifying government.*

9.2 The purpose of the notification regarding control action is to give competent authorities in other countries the opportunity to assess the risks associated with the pesticide, and to make timely and informed decisions as to the importation and use of the pesticides concerned, after taking into account local, public-health, economic, environmental and administrative conditions. The minimum information to be provided for this purpose should be:

9.2.1 the identity (common name, distinguishing name and chemical name);

9.2.2 a summary of the control action taken and of the reasons for it – if the control action bans or restricts certain uses but allows other uses, such information should be included;

9.2.3 the fact that additional information is available, and the name and address of the contact point in

1/ A specific procedure exists for selecting pesticides to be included in the PIC procedure. These include pesticides that are banned, or severely restricted, as well as certain pesticides that are acutely toxic. This procedure is described in the FAO Guidelines on the Operation of Prior Informed Consent.

the country to which a request for further information should be addressed.

Information Exchange Among Countries

9.3 If export of a pesticide banned or severely restricted in the country of export occurs, the country of export should ensure that necessary steps are taken to provide the designated national authority of the country of import with relevant information.

9.4 The purpose of information regarding exports is to remind the country of import of the original notification regarding control action and to alert it to the fact that an export is expected or is about to occur. The minimum information to be provided for this purpose should be:

9.4.1 a copy of, or reference to, the information provided at the time of the notification of control action;

9.4.2 indication that an export of the chemical concerned is expected or is about to occur.

9.5 *Provision of the information regarding exports should take place at the time of the first export following the control action, and should recur in the case of any significant development of new information or condition surrounding the control action. It is the intention that the information should be provided prior to export.*

9.6 *The provision to individual countries of any additional information on the reasons for control actions taken by any country must take into account protection of any proprietary data from unauthorized use.*

Prior Informed Consent

9.7 *Pesticides that are banned or severely restricted for reasons of health or the environment are subject to the Prior Informed Consent procedure. No pesticides in these categories should be exported to an importing country participating in the PIC procedure, contrary to the country's decision made in accordance with the FAO operational procedure for PIC.*

9.8 *FAO will:*

9.8.1 *review notifications of control actions to ensure conformity with definitions in Article 2 of the Code, and will develop the relevant guidance documents.*

9.8.2 *in cooperation with UNEP, develop and maintain a data base of control actions and decisions taken by all member governments;*

9.8.3 *inform all designated national authorities and relevant international organizations of, and publicize in such form as may be appropriate, notifications received under Article 9.1 and decisions communicated to it regarding the use and importation of a pesticide that has been included in the PIC procedure.*

9.8.4 *seek advice at regular intervals and review the criteria for inclusion of pesticides in the Prior Informed Consent procedure and the operation of the Prior Informed Consent scheme and will report to member governments on its findings.*

9.9 Governments of importing countries should establish internal procedures and designate the appropriate authority for the receipt and handling of information.

9.10 *Governments of importing countries participating in the PIC procedure, when advised of control actions within this procedure, should:*

9.10.1 *decide on future acceptability of that pesticide in their country and advise FAO as soon as that decision has been made;*

9.10.2 *ensure that governmental measures or actions taken with regard to an imported pesticide for which information has been received are not more restrictive than those applied to the same pesticides produced domestically or imported from a country other than the one which supplied the information.*

9.10.3 ensure that such a decision is not used inconsistently with the provisions of the General Agreement on Tariffs and Trade (GATT);

9.11 *Governments of pesticide exporting countries should:*

9.11.1 *advise their pesticide exporters and industry of the decisions of participating importing countries; and,*

9.11.2 *take appropriate measures, within their authority and legislative competence, designed to ensure that exports do not occur contrary to the decision of participating importing countries.*

Guidelines for the Operation of Prior Informed Consent

Executing Agency. The Report of the Expert Consultation on the Introduction of "Prior Informed Consent" in Article 9 of the Code stressed the importance of cooperation between UNEP and FAO in the operation of a PIC scheme. Because of FAO's expertise in the field of pesticide use, management and control, and because of the comprehensive network of FAO contacts in UN member nations, FAO will operate the PIC scheme as far as pesticides are concerned. FAO will also, in cooperation with UNEP, manage and implement the scheme, including the selection of pesticides to be covered by the PIC scheme, mechanisms for information exchange and compatibility of procedures.

Operation of Prior Informed Consent

Step 1 - Participation in PIC. Member Nations will be invited, through official FAO channels, to participate in the PIC scheme as importing countries. If there is no reply to the initial contact, a follow-up letter will be sent 60 days after the first one. In countries where there is FAO representation, FAO representatives will seek a decision from the country. Until a response is received, it will be assumed that the country does not wish to participate. It is expected that all pesticide exporting countries will participate in the PIC scheme.

Step 2 - Designation of National Authority. Member nations will be invited to designate the appropriate authority which should supply FAO with the notices of control action taken by the government. This authority will be responsible for receiving and giving notices on decisions on whether the country wishes (to continue) to receive imports of pesticides included in the PIC procedure. For information purposes FAO will also be informed about the authority that has technical responsibility for pesticide use and/or control (registration authority or equivalent).

Step 3 - Notification on Control Actions. The designated national authority would advise FAO of control actions taken in the country to ban, to refuse registration, or severely restrict a pesticide for health or environmental reasons, as included in the definition, as well as any other actions to withdraw a pesticide for health or environmental reasons. This does not include actions to revoke or withdraw a pesticide registration for non-submission of data or for commercial reasons.

In deciding to notify, countries must abide by the definitions of banned and severely restricted in the Code of Conduct:

- **Banned** means a pesticide for which all registered uses have been prohibited by final government regulatory action, or for which all requests for registration or equivalent action for all uses have, for health or environmental reasons, not been granted.

- **Severely restricted** – a limited ban – means a pesticide for which virtually all registered uses have been prohibited by final government regulatory action for health or environmental reasons but certain specific registered use or uses remain authorized.

The information forwarded to FAO should be provided in the format shown in Box 6, p. 122. The reasons for the control action for health and environmental reasons should be provided in each case. A separate form should be completed for each pesticide, and countries should be prepared to provide additional detailed information on request. In addition, pesticides which are voluntarily withdrawn by their manufacturer for health or environmental reasons should be reported.

Step 4 - Selecting Pesticides to be Included in the PIC Procedure. FAO will, in cooperation with UNEP/-

International Register of Potentially Toxic Chemicals (IRPTC) and other relevant organizations, review all notifications to ensure conformity with the definitions. Pesticides will be included in the PIC procedure when FAO is advised by a government that it has taken final control action consistent with the definition of banned or severely restricted for health or environmental reasons in the Code of Conduct on the Distribution and Use of Pesticides.

Additionally, an FAO Expert Panel will consider the problem of acutely hazardous pesticide formulations, i.e. those that pose particular handling problems, to determine if there exists a need for a list of such products to supplement the pesticides already subject to the PIC procedure. This Panel should include national pesticide registrars and representatives from WHO and UNEP. They may call upon expertise as they deem necessary and will review formulations which are included in WHO Class Ia. If the Panel concludes that there are acutely hazardous pesticide formulations of concern to developing countries that are not already included in the PIC procedure, a supplemental list of such formulations will be recommended for inclusion.

FAO will develop a "PIC Decision Guidance Document" for each pesticide to be circulated with the notice of control action for response by participating importing countries and for the information of other countries.

Pesticides Already Subject to Control. For pesticides that have already been subject to control action, a different procedure will be followed. Close cooperation with UNEP/IRPTC will be sought for such a procedure. All FAO member governments will be asked to submit notifications of pest control actions for health and safety reasons before 31 December 1989. These will then, in cooperation with relevant organizations, together with information already available in IRPTC, be evaluated on their conformity with the definitions. PIC guidance documents will be developed — initially for pesticides banned or severely restricted in five or more countries — for those pesticides that conform to the definitions. These PIC guidance documents will be submitted to participating governments for decision.

Step 5 - FAO Processing of Notification. FAO will inform its member nations of control actions taken and will send a PIC guidance document on the pesticide to the designated national authority. This document will provide a summary of information including chemical and physical properties, uses, source of exposure, toxicity profile, countries that have taken control actions and the reasons for such actions and also, when available, suggested possible alternatives. It should be recognized that any suggestion of alternatives can only be general in nature, as specific alternatives can only be recommended following a careful study of the pest-crop complex in an individual country.

Step 6 - Response by Participating Countries. After each notification, each importing country that has decided to participate in the PIC procedure in Step 1, will advise FAO whether or not it will allow imports of the pesticide(s) in question. A response should be made within 90 days of advice being sent from FAO to the designated national authority. A country may make a final response, or an interim response.

- A **final response** will consist of a statement by the national authority as to whether or not the country will ban imports for health or environmental reasons. It is understood that the country will also discontinue production for the national market if importation is banned for health or environmental reasons, or whether importation will only be allowed under specified, stated conditions. It is also understood that the importing country may wish to permit the use of products that are in stock at the time the prohibition of imports is imposed.

- In an **interim response**, the country would advise about each pesticide in the PIC procedure in one of the following ways:

  - a request for further information;
  - a statement that future importation is under review; and
  - a request for assistance to evaluate the pesticide.

Any of the replies may be accompanied by an interim importation statement that the importation will or will not be allowed, or whether importation will only be allowed under specified, stated conditions, during the period until a final decision is reached. In the event

that such a statement is not made, the status quo will continue (see "meaning of no response" below).

- **Meaning of No Response.** In some instances a participating importing country may not respond. Every effort will be made to avoid such a situation, but if it does occur, it will be considered as described below.

If a country does not make a response or if it responds with less than a final response without providing an interim importation statement, the status quo with respect to importations will continue. This means that the pesticide should not be exported without the explicit consent of the importing country, unless the exporter has evidence that it is a pesticide that is registered in the importing country or is a pesticide the use of which has been allowed by the importing country.

National Control in Imports. At the time an interim or final decision to ban importation for health or environmental reasons is made, the national agency responsible for controlling imports will be instructed to take the relevant import control action. Wherever relevant, local production will also be subjected to the control action. Importing countries would take all necessary measures to prohibit importation and local production.

Step 7 - Action to be Taken by FAO. FAO will advise all designated national authorities of the responses of individual countries. FAO will maintain, jointly with UNEP, a data base on country decisions and will also make information available to national authorities at regular intervals on the appropriate form. FAO will seek advice at regular intervals and review the criteria for inclusion of pesticides in the PIC procedure and the operation of the PIC scheme and will report to its member governments on its findings.

Step 8 - Action to be Taken by Exporting Countries. National authorities of exporting countries would inform the appropriate authorities and the pesticide export industry of decisions by importing countries. Governments would take appropriate measures, within their authority and legislative competence, designed to ensure that exports do not occur contrary to the decisions of participating importing countries.

Information Exchange

The successful operation of the PIC process for pesticides is completely dependent on the free exchange and rapid processing of information provided by various countries. The PIC procedure is in addition to, and does not replace, any system of information exchange between countries, nor does it affect the right of any country to seek additional information on the reasons for any control action which a country may take on a pesticide.

PIC Decision Guidance Documents

These documents which are referred to in the Guidelines are intended to provide importing countries with information on the pesticides which are included in the PIC process. Information will include the chemical and physical properties, uses, sources of exposure, toxicity profile, countries that have taken action to ban or severely restrict the pesticides (after the definitions in the Code of Conduct) and the reasons for such action, the name and address of the country authority from where further information can be obtained and, in the case of severely restricted pesticides, a list of the uses remaining. At this stage, these documents are not expected to include alternative pesticides.

A proposed draft outline of a Decision Guidance Document is shown in Box 7.

Box 6. **Banned or Severely Restricted Pesticides**

Report to FAO[1]

1. COUNTRY .....

2. NAME, ADDRESS AND CONTACT OF ORGANIZATION SUPPLYING INFORMATION
   .....
   .....
   .....
   Telex ..... Telephone ..... Fax. .....

3. IDENTITY OF PESTICIDE
   Common name .....
   Distinguishing name .....
   Chemical name .....

4. SUMMARY OR REASONS FOR BANNING OR SEVERELY RESTRICTING
   .....
   .....

5. SUMMARY OF REMAINING USES OF SEVERELY RESTRICTED PESTICIDES
   .....
   .....

6. NAME, ADDRESS AND CONTACT FOR FURTHER INFORMATION (if different from 2)
   .....
   .....
   .....
   Telex ..... Telephone ..... Fax .....

7. LIST ANY RELEVANT REFERENCES
   .....
   .....
   .....

8. DATE ABOVE DECISIONS CAME INTO FORCE
   .....
   (Date) ..... (month in words) (Year)

9. SIGNATURE ..... (Person)
   ..... (Designation)
   ..... (Date as day/month/year)

1/ An additional sheet(s) may be added in the event that space provided in this form is inadequate.

Box 7. Decision Guidance Document (DGD)

To assist countries in arriving at a decision regarding use and import of _____ (Pesticide)

Date Prepared
Day/Month

DGD/Year/Issue
Pesticide

1. IDENTIFICATION

1.1 Common name:
1.2 Main use(s):
1.3 Chemical type:
1.4 Chemical name:
1.5 Trade name(s):
1.6 Identifying numbers:

2. INFORMATION ON CONTROL ACTIONS

2.1 General:
2.2 Actions taken:

2.2.1 Banned:
2.2.2 Severely Restricted:
2.2.3 Uses Retained:

2.3 Reasons for Action:
2.4 Contacts for Further Information:
2.5 Sources of Information:

3. SUMMARY OF FURTHER INFORMATION ON THE PESTICIDE

3.1 General Description of the Pesticide:
3.2 Chemical and Physical Properties:
3.3 Toxicological Profile:

3.3.1 Oral LD_{50} (Active Ingredient):
3.3.2 Dermal LD_{50} (Active Ingredient):
3.3.3 WHO Classification:

Active Ingredient Formulation
3.3.4 General: Subchronic and Chronic Effects:
3.3.5 Treatment of Poisoning:

Box 7. Decision Guidance Documents, continued

3.4 Environmental Effects Profile:

3.4.1 Persistence:
3.4.2 Effects on nontarget species:

3.5 Residues in Food Profile:

3.5.1 General:
3.5.2 Codex Maximum Limits:

3.6 Alternative Pest Control Measures (if available):

3.7 References:

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